AUTOMATION

MARCH 1961

Machining Railroad Wheels

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

- Planning Automated Assembly
- Magnetic Tape Control of Turret Lathe
- Load Sensing Conveyor
- Applying Optoelectrical Readout

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A PENTON PUBLICATION

VAUGHN HAYES, Manager of Production Engineering, says:

"This Wean Slitting Line gives Chrysler Corporation's Twinsburg plant increased flexibility in production planning

by allowing us to purchase standard size mill coils. We slit these coils to meet specific production requirements, eliminating special-width coil purchases. The line's 2,000 ton-per-month output helps us eliminate production delays and coil supply problems." Mr. Hayes' comments are typical of reasons why companies are using the *coil processing concept* to lower material costs, reduce inventory requirements and decrease scrap loss. If you process 500 tons or more per month of flat rolled metals, write for our new brochure entitled, "Coil Processing."

This brochure explains the concept and economics involved in *coil processing.* It also illustrates the types of Wean equipment that can help you cut inventory, production, and material costs when you process standard *mill* coils instead of sheets.

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THANK YOU . . .

for your enthusiastic response to this announcement. Because it has been viewed as an important advance in valve development, we reprint this news for those who missed its first appearance.

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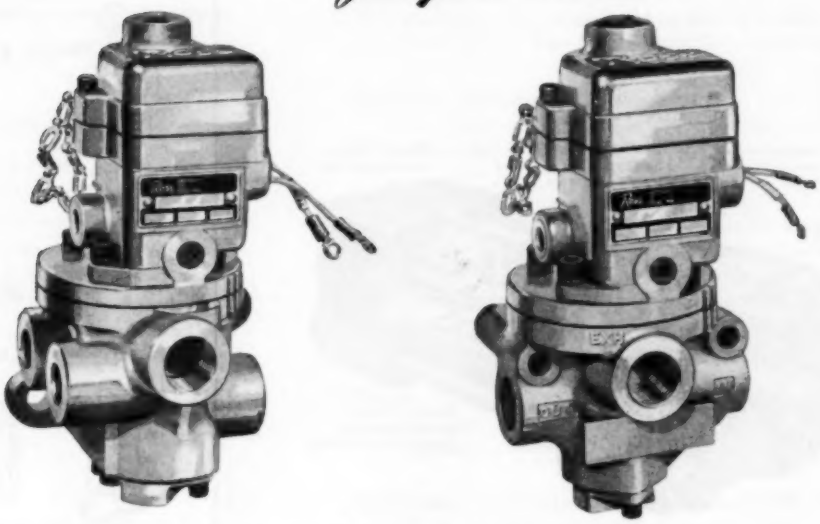

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Ross OPERATING VALVE COMPANY

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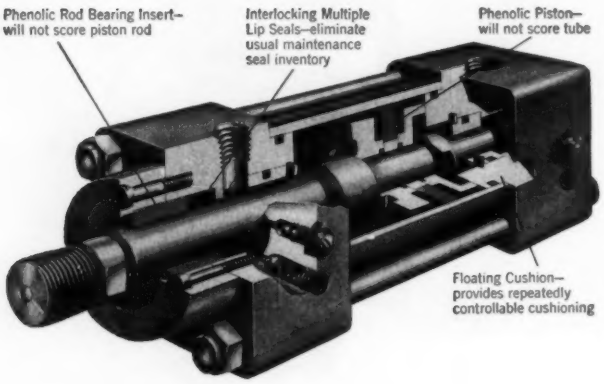
Fluid Circuitry News from Westinghouse

Industrial Product Division expands line

The Petch line of high quality air and hydraulic cylinders is now part of the line of Westinghouse Fluid Circuitry components. This acquisition makes it possible for us to offer industry the *most complete line* of air and hydraulic components for control systems to automate industrial production operations.


Phenolic Rod Bearing Insert–will not score piston rod
Interlocking Multiple Lip Seals–eliminate usual maintenance seal inventory
Phenolic Piston–will not score tube
Floating Cushion–provides repeatedly controllable cushioning

The Petch line of rugged, precision made cylinders include the following models:

Air & Low Pressure Hydraulic Cylinders

150 psi Air 500 psi Hydraulic
1″ to 10″ Bores
10 Standard Mountings

High Pressure Hydraulic Cylinders

1½″ to 6″ bores—2000 psi
8″ to 10″ bores—3000 psi
10 Standard Mountings

All Petch Cylinders conform to J. I. C. Standards.

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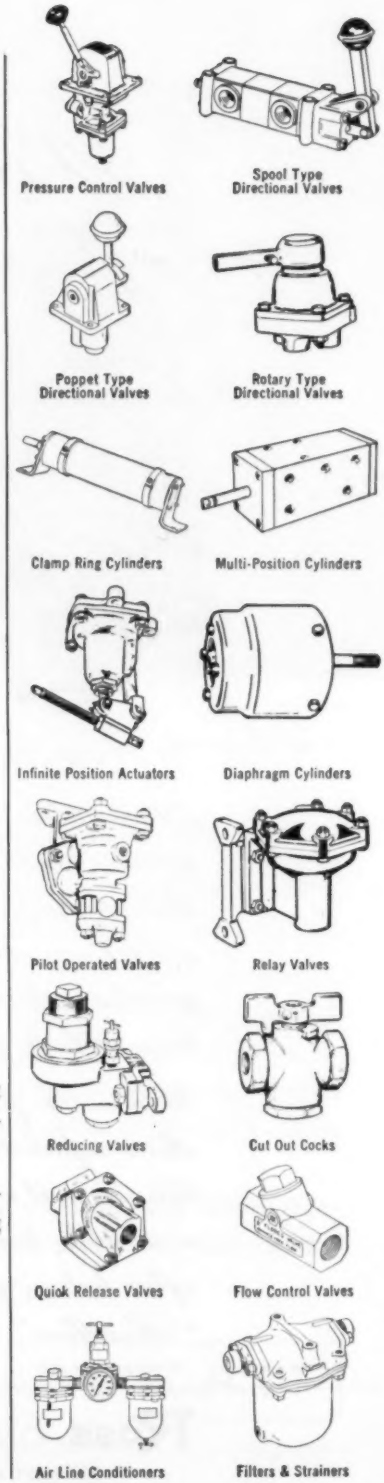
Fluid Circuits are economical, safe and precise. They are used to solve the most vigorous and complex control problems.

They contain reliable products to boost your production and cut your production costs.

For more information on Petch Cylinders and Fluid Circuitry ask for catalog A3-56.00.

See the Yellow Pages under Cylinders for the Name of Your Local Distributor, or refer to Sweet's Catalog, Product Design File.



WESTINGHOUSE AIR BRAKE COMPANY
INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA

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The Magazine of Automatic Manufacturing Operations

MARCH 1961
Vol. 8 — No. 3

AUTOMATION®

A PENTON PUBLICATION

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automation outlook

WHAT DEPRECIATION?

FROM a study of the many writings on depreciation, most efforts appear to be concentrated on selecting the right depreciation method to use. While this is certainly good sense, it can often be a camouflage obscuring the real decision to be made. What great point is there to selecting one of three very nearly identical methods, unless the study has first been made as to the basic character of the investment itself? Is it purely a capital investment or is it really expense—expense either in the way of characteristically expendable "wear-out" elements or in truly developmental research?

The fact is that individual policy varies widely to the extent that many decisions obviously hinder general industry advances while aiding some particular individual circumstances. A look at equipment builders' comments reveals the dilemma: ". . . we have run the gamut of customers who wish to capitalize as much of the equipment as possible, to those who wish to 'expense' as much as possible. There seems to be a wide variance in accounting policy from one company to another and the internal procedures vary to the extent that persons trying to justify new equipment desire to have the breakdown of basic costs vs. expendable costs in a manner which will favor approval . . . . depreciation policy seems to be lost in this scramble."

A recent study of depreciation policy in some 1325 establishments by the Controllers Institute Research Foundation confirms this variation and this comment on their findings is worth noting:

"Partly because of the high rate of income tax many enterprises have adopted a policy of tax management, under which every legitimate means is used to reduce the tax bill and preserve cash. Obviously, to make the most profitable decisions under this policy, forecasts must be made for several years ahead. Under such 'tax accounting,' expenditures which before the advent of income taxes might have been capitalized, are charged to operations. . . . But except for circumstances such as (depletion and rising taxes), should not 'tax accounting' result in the use of maximum depreciation? Would not such a policy dictate the use of both S.O.Y.D. depreciation and declining balance depreciation? Would not each be used so that the greatest depreciation will accumulate, and result in an optimum accumulation of tax deferment? If the answer to these questions is 'yes' then it seems surprising that less than 17% of the companies reporting the use of accelerated depreciation are using both kinds.

In our own studies of the depreciation problem we have found that the comment ranges from ". . . a fiction" to "absolutely necessary." And all shades of thinking between show up in detailed discussion with top management. The vital need for separating practices designed for dealing with new, unusual, and improved facilities and those for plain garden-variety replacement seems to be largely overlooked. IRS Code reform to stimulate rather than restrict improvements in our manufacturing practice is highly desirable, but management must aid this movement with more thorough and longer range equipment policy.

The final admonishment of the Controller's study is a real understatement of fact—"In any case, it appears that many companies would find it advantageous to review their depreciation policy." We recommend a complete restudy of capital equipment policy to reorient practice to suit the needs of 1961.

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BPA NBP

Fluid Power news

OILGEAR 40 Years of Fluid Power

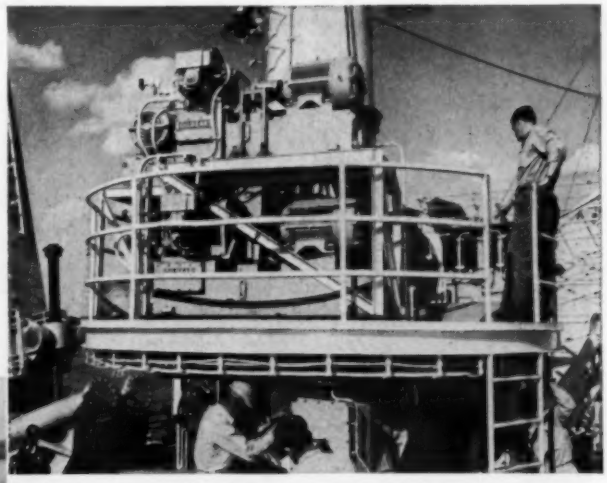
From Oilgear *Application-Engineering* Files

HOW OILGEAR HEAVY-DUTY ELECTROHYDRAULIC POWER AND CONTROL SYSTEMS SERVE OVER 125 APPLICATIONS ON SEAGOING HOPPER DREDGE *"MARKHAM."*

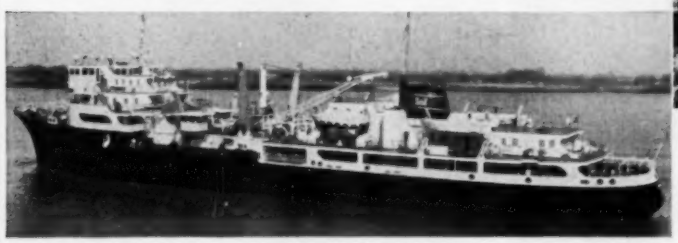
USER AND DREDGE DESIGNER: *U. S. Army Corps of Engineers*

BUILDER: *Avondale Marine Ways, Inc., New Orleans, Louisiana*

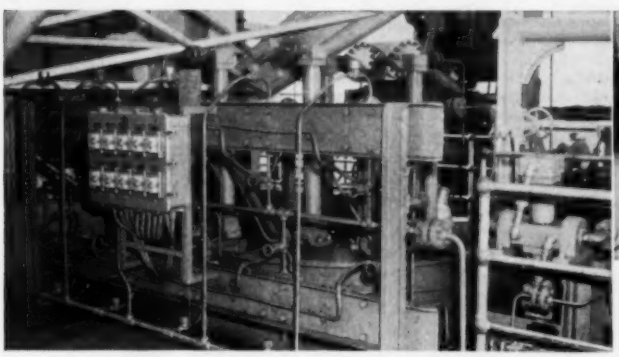
The **"MARKHAM"**—constructed in accordance with A.B.S. and U.S.C.G. requirements, and largest suction dredge for Great Lakes harbor and channel maintenance—has Servocontrol Valve-equipped Oilgear Drives on Post Crane—Main, Whip, Topping Hoists and Rotating Machinery; and Anchor Windlass. Two Cargo Winches have Oilgear servo-motor lever hand-controlled drives. Oilgear Pumps, Cylinders, and Valves operate twelve 24-in. pump room valves, thirteen jetting valves, three sea valves, brakes and clutches on drag winches, forty mixing well gates, eight hopper dump gates, eight hopper distribution nozzle gates, and two gas collecting system valves . . .
over 125 Oilgear Power and Control applications.



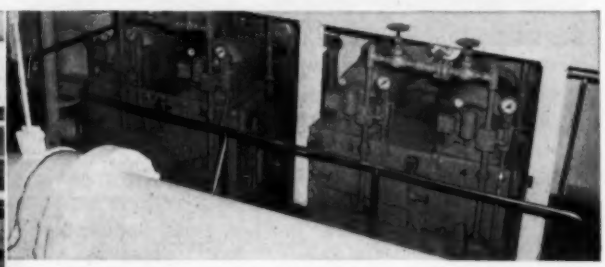
Post crane, with long boom, features remote, manual-controlled, Servocontrol Valve-equipped Oilgear Drives for all functions. Main hoist drive has a "DV-20" Pump and "H-20" Motor to handle loads to 20,000 lb at any speed up to 25 fpm. Whip hoist drive has a "DV-20" Pump and "H-20" Motor to handle loads to 4,000 lb at any speed up to 125 fpm. Topping hoist has a "DV-35" Pump and "H-20" Motor to raise full-loaded boom in 2½ minutes. Rotating drive with "DV-35" Pump and "H-20" Motor turns full-loaded crane 360° at ½ rpm. All drives are capable of handling a 50% overload. Manual operating levers, pushbutton stations, drive pressure gages, and pump stroke indicators are on a central control console.



Seagoing Hopper Dredge *"MARKHAM,"* launched June 10, 1959, is 339'6" long, has a 62' beam and 28' draft amidships. Hopper capacity—2,680 yards. Loaded Displacement—7,700 tons. Capable of dredging to a depth of 43'6", this diesel-powered vessel has a rated speed of 13 mph fully loaded, and 14½ mph light. The keel was laid at *Avondale* on July 29, 1958.



One of the four mixing wells—ten Oilgear double-acting cylinders operate the gates for each well. Oilgear trunnion cylinder, at right, operates distribution nozzle gate. Oilgear *"Power-Paks"* supply fluid power for operating over 100 cylinders. Two cargo winches on the forward deck feature Oilgear *"Any-Speed"* Drives manually controlled from the forecastle deck. Each winch uses an Oilgear "DH-4" Pump and "H-8" Motor Drive to lift 3,200-lb. loads at any speed up to 50 fpm.



Two Oilgear *"Power-Paks"*—one is a "stand-by"—supply fluid power for operating over 100 cylinders that actuate 6 drag winch brakes, 8 drag winch clutches, 30 valves, and 56 gates. Each 600 gallon reservoir mounts two Oilgear "CG-60" Constant Displacement, Radial Piston Pumps and their electric drive motors. Each pump delivers 67.2 gpm at any pressure up to 1750 psi. The Anchor Windlass also features a Servocontrol Valve-equipped Oilgear Drive with manual control unit located on the forecastle deck. An Oilgear "DV-60" Pump and "H-60" Motor Drive (not shown) handles two 7,000-lb anchors simultaneously at any speed up to 5 fathoms per minute. An electric brake on the Oilgear Motor tailshaft is interlocked with the pump control.

For Lowest-cost-per-year operation on ANY application ..it's Oilgear! This fact has been proved by over 50,000 nominal horsepower of Oilgear Pumps on marine steering gear installations alone. Other marine applications include mobile drilling barges, elevators, catapults, capstans, large valve controls, lock and dam gates and bridges.

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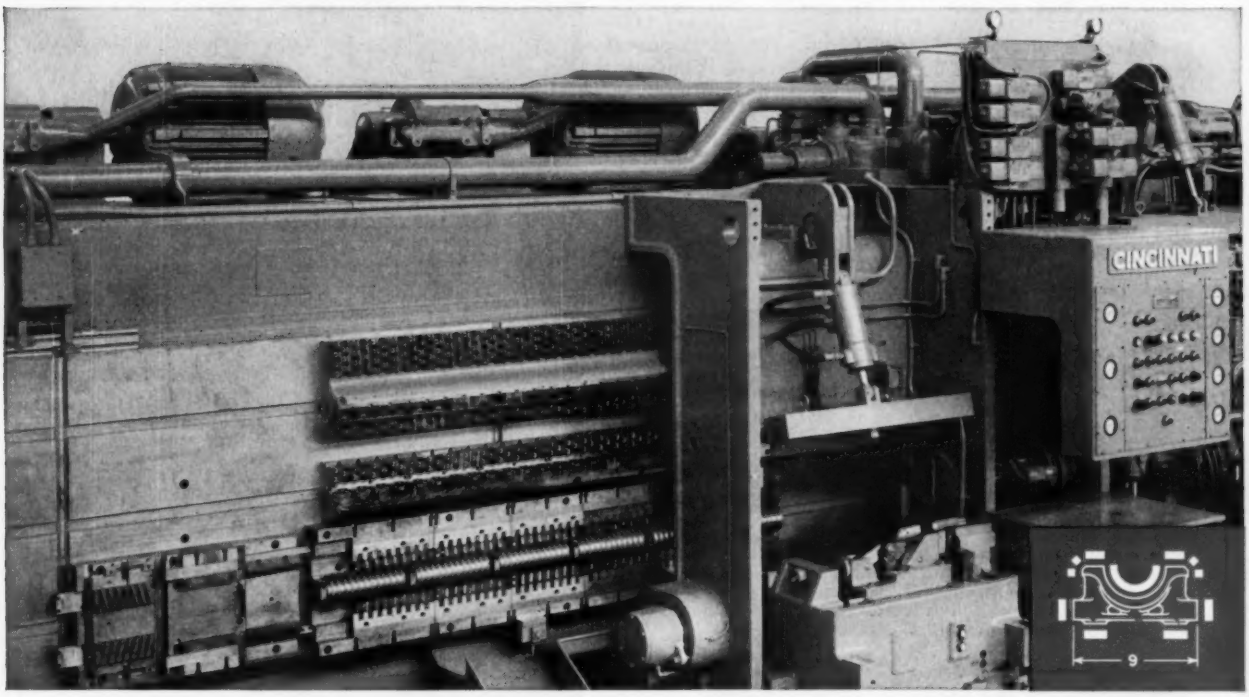
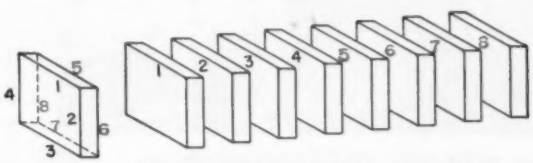
How Throw-away Tool Bits..



Thirteen sizes of main bearing caps are surface broached on this CINCINNATI Horizontal Hydro-Broach Machine. Throw-away tool bits help in keeping costs at a minimum while producing 80 parts per 48 minute hour. Catalog M-1910 contains specifications.



C. H. Altbaier, Manager of Sales, Special Machine Division, The Cincinnati Milling Machine Co., holds a wood model of a throw-away tool bit as he demonstrates how throw-aways are applied to broaching. (Patent pending)

DESIGNERS AND BUILDERS OF SPECIAL MACHINES • HORIZONTAL BROACHING MACHINES •

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO

. . enhance any degree of automation in surface broaching

In the past, throw-away tool bits have been very successful in turning, milling and planing operations. Surface broaching is the latest candidate. Through an ingenious tool holder arrangement, developed by Cincinnati Milling's Special Machine Division, throw-aways are used eight times before discarding. Let's assume that we have sintered carbide bits. Using only one cutting edge, 20,000 or more parts can be broached. The bits are unclamped, turned 90° and the second edge is available to broach another 20,000 parts, and so on. Both sides of the bit are used (negative rake angle). Then there are eight cutting edges, as indicated in the drawing and demonstrated by Mr. Altbaier, Manager of Sales, Special Machine Division.

And now let's see how the idea is working out in actual practice. The CINCINNATI Horizontal Hydro-Broach Machine, left, broaches several surfaces on 13 sizes of main bearing caps. Fixtures are the progressive type, for the following sequence of four operations: 1) thrust face, 2) opposite thrust face, 3) bolt head seats, 4) half bore, joint face, bearing lock and chamfer. Cutting tools for the half bore and finishing operations are the conventional brazed carbide type, while others are throw-aways. In actual production during the past several months, throw-away tool bits are indexed every 24,000 to 29,000 parts, and eight cutting edges are used. Remember, there is no cutter sharpening expense. So there you have a simple solution to reducing unit production costs.

This machine and tooling are typical of the advanced thinking and modern approach to low-cost production which Cincinnati imparts to broaching machines, production lines, and every type of equipment built to your requirements by the Special Machine Division. Many specialists in this Division are available to study your machining problems and recommend equipment to reduce costs and improve quality. May we hear from you?

CINCINNATI

COMPLETELY AUTOMATED PRODUCTION LINES

CINCINNATI

SPECIAL MACHINE DIVISION

Circle 657 on Page 35

Set the dial *and let 'em roll!*

FROM RECEIVING TO PRODUCTION TO SHIPPING . . . VIA *TOWMATIC!!

AUTOMATIC SWITCHING TOWVEYORS? We custom-make them to fit your exact specifications . . . from small detachable selector units offering up to six dispatching points, to large elaborate units offering up to 100 different dispatching points! We call it TOWMATIC. Since its inception, several years ago, Webb has installed *more* automatic switching towveyors *than any other manufacturer.*

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Towveyor installations are custom-made to suit the specific layout for which it is intended. So, whether you are operating out of a two-car garage, or a million square foot establishment, it will pay you to investigate the possibilities of Towmatic. Call a Webb Engineer today . . . he'll show you how to increase your profits through efficient materials handling methods.

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OFFICES IN ALL PRINCIPAL CITIES

Circle 658 on Page 35

AUTOMATION news

Today's events and developments in the field of automation

Nation's Railroads Seeking Car Identification System

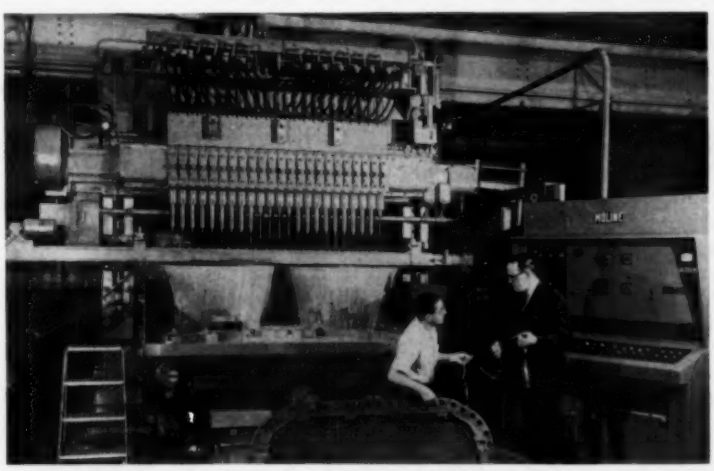
RAILROADS of the United States have been aware for many years that automatic means of identifying train equipment are desirable to replace the costly and cumbersome method now employed of walking tracks, writing car numbers, and manually copying and comparing number lists. Individual roads have from time to time approached various manufacturers in this regard, but in each case implementation of a system has been stymied by the realization that it is a move that all railroads must make together.

Within the past year, a group of research and engineering people, representing five or six progressive roads, have met in informal sessions to discuss the problem of automatically reading and recording car initials and numbers as cars pass certain points or are shuttled in and out of yards tracks. One such meeting took place in December in Cleveland, and a performance specification for a freight car identification system was developed. The meeting was sponsored by the Denver and Rio Grande Western Railroad Co. and was attended by representatives of various railroads and interested equipment manufacturers.

In general, the railroads feel that some form of automatic car identification is needed to eliminate a time consuming manual job involving tons of paper work. In order for the automatic system to work, all railroads must use the same system, or compatible systems. The railroads are seeking a scanner, complete with signal processing unit, to generate a 5-level teletype code for transmission that will cost no more than $5000 per unit. The scanner will be energized by a device on each freight car, costing not more than $5 per car including installation, which is capable of transmitting three letters and six numbers at car speeds up to 60 mph.

The automatic system must be universal to enable the railroads to gain the maximum benefit. Total cost of the system must be such that when a certain percentage of the railroads agree to adopt the system, they can afford to apply the devices to all railroad cars. Preliminary economic studies based on the proposed costs indicate that twenty railroads, representing 80 per cent of the total car ownership, are justified in installing the car devices on their own cars as well as nonmember cars to realize financial savings inherent in this system.

Additional technical details of the specification will be found in the Confidential File, page 154, of this issue.



TAPE-CONTROLLED multispindle drilling machine was built to specifications of Carrier Air Conditioning Co. by Moline Tool Co. Purpose of the machine is to reduce production expenses and speed up delivery of big-capacity cooling machines. Here being examined, is one of the six-foot tapes which control the patterns of holes drilled in cooler and condenser tube sheets. Each tape replaces one of the heavy steel jigs (foreground) formerly used in drilling. Tapes for the $150,000 machine can be produced in a fraction of the time required to engineer a jig and can be stored in a small cabinet next to the machine. Machine shown is one of two units to be used by Carrier.

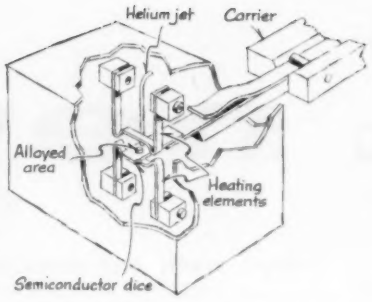
Bonding Process Joins Copper Parts

NEW TECHNIQUE for joining copper to copper and certain alloys to copper has been developed by Chase Brass & Copper Co., a subsidiary of Kennecott Copper Corp. The process joins two or more copper components together with a homogeneous bond which is as strong as or stronger than the base metal. A special coating on the metal surface diffuses into the parts to be joined and under proper conditions produces a bond without an interface. The coating can be applied to copper strip before it is rolled to finished gage, or it can

be applied to fabricated parts. The integral coating makes it unnecessary to apply the joining material by conventional methods. This is expected to offer a practical way to automate joining operations which are now primarily manual. It is anticipated that the diffusion bonding process will be particularly useful in applications where joints must be vacuum tight, free of high vapor pressure constituents, and capable of operating at elevated temperatures.

Power Plant To Modernize With Computer Control

INSTALLATION of an automatic control system in Gulf States Utilities Company's Riverside Power Station will include application of computer control in the modernization of an existing 70,000-kilowatt generating plant. Allis-Chalmers Mfg. Co. will design, furnish, and install the complete system for automatic control and will modify existing equipment as required. The instrumentation and data processing system necessary for computer operation of the facility will be designed and manufactured by Consolidated Systems Corp. Faster startup of the plant including boilers and steam turbines, will be a feature of the new system. When operating, the plant will be able to respond more rapidly to changing power requirements.



NEW PRODUCTION PROCESS which has made possible the development of a silicon precision alloy transistor (SPAT) has been announced by Philco Corp. The new transistors are produced by a unique strip alloy technique, making possible unprecedented product uniformity. In the strip alloying process, each transistor is indexed on a precision carrier which guides the device into a miniature alloying furnace and positions it in perfect alignment with the heat source. This method allows every transistor to be heat-treated indentically and also permits precise monitoring of the alloying conditions of each transistor.

Metal Sheets Produced From Powders

PROCESS FOR continuous production of commercial sheet metals and alloys is being developed at Stevens Institute of Technology by the college's Powder Metallurgy Laboratory. It is expected that the process will make possible the production of sheet metals or alloys in a continuous operation, saving time, reducing production costs, and increasing plant efficiency.

With this process, metals or alloys in the form of fine powders are suspended in a liquid. The resulting suspension resembles the pulp suspension used in the manufacture of paper. The sheets produced are continuously passed through controlled-atmosphere furnaces where they are brought up to temperatures just below their melting point. This sintering operation consolidates the sheets

Fifth Conference on Manufacturing Automation Next Month

G. M. MUSCHAMP

F. SMITH

AUTHORITATIVE speakers from diversified industries will again highlight the Conference on Manufacturing Automation to be held on the campus of Purdue University on April 17, 18, 19. As in the past, papers on various phases of the planning, building, and operating of automated machines, lines, and plants will be given.

Banquet speaker for the conference will be **George M. Muschamp,** Vice President-Engineering, Industrial Products Group, Minneapolis-Honeywell Regulator Co. His topic will be *Coming: Automatic Controls' Greatest Era.* In his work, Mr. Muschamp is responsible for the co-ordination and integration of product programs and the technical evaluation and planning of long-range needs in the areas of industrial process and laboratory and test instrumentation, high-speed analog and digital data acquisition and reduction systems, and computer directed control systems.

Speaking at the Monday luncheon will be **B. T. Hensgen,** Associate Director, Engineering Research Dept., Swift & Co., on the subject of *Automatic Disassembly—Meat Packers' Problems.* Tuesday's luncheon speaker will be **Floyd Smith,** President, Vibratory Feeder Co.; his topic will be *Ingenuity and Engineering—Unusual Problem Parts Feeders.* Wednesday, the luncheon speaker will be **E. A. McKenna,** Chief Industrial Engineer, Schenley Industries Inc., discussing *Bottled in Bond—Automating the Distillery.*

Details on other speakers will be given next month. Additional information on the Fifth Conference on Manufacturing Automation is given on page 156.

B. T. HENSGEN

E. A. McKENNA

"IMAGINATION IS MORE IMPORTANT THAN KNOWLEDGE"

Albert Einstein

There are some who might argue this point with Einstein. But this much is certain: Wherever new knowledge is sought, imagination lights the way. And surely, only imagination of rare quality could have led Einstein to formulate his principle of relativity.

Einstein applied the insight of imagination to basic science. But imagination can be just as powerful in the creation and application of technology. And nowhere, perhaps, is imagination challenged over so wide a range in both science and technology as in the problems of electrical communications.

At Bell Telephone Laboratories, scientists and engineers range far and deep in search of the answers. They probed deep into solid-state physics to discover the transistor principle, and they speculated and synthesized in an entirely different area of knowledge to create the giant microwave system that carries your TV programs across the country. They study ways to protect the giant molecules in plastic cable sheath, and they explore the basic information content of speech to devise better ways to transmit it. They devise ultrasensitive amplifiers to capture radio signals from distant places, while they conceive and develop new switching systems of unprecedented capabilities. Side by side with the development of transoceanic cable systems they are exploring the possibilities of world-wide communications via man-made satellites.

By exploring every pathway to improved electrical communications, they have helped make your Bell System communications the world's best and they will work to keep it so.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

NORDEN Modumatic Control for New and Existing Machines

Series 100 features

- ☆ Actual Position Readout
- ☆ Decimal Display
- ☆ Full Range Origin Select

IF you have the time-consuming problem of rotary or linear positioning, then you are aware of the importance of knowing the exact location of the tool or the work piece. Up until now this was a tedious, time-consuming process requiring calculation and dial reading, both subject to human error. Norden's Series 100 display system eliminates all this and performs the calculations automatically. What's more, it can be installed on **new** and **existing** machines.

The Series 100 numerical control system utilizes a unique position feedback transducer, electronic circuitry and a visual display to indicate the **actual** position of the tool or work piece.

The **actual** position is displayed in straight decimal form by illuminated numbers that are readable from twenty feet. The display unit may be located on the machine or remote.

This Norden Modumatic system also offers a full range electronic origin select so that any desired offset can be quickly and easily dialed in by the operator on manual selector switches.

For more information about this position display system or other Modumatic control systems contact your nearest Norden Representative—400 Main Street, East Hartford, Connecticut, JAckson 8-4811, 11 West Monument Ave., Dayton 2, Ohio, BAldwin 8-4481, or write to us at the address below.

A new concept in Numerical Control

from ☆ **NORDEN** ☆ **DIVISION OF UNITED AIRCRAFT CORPORATION**

DATA SYSTEMS DEPARTMENT

COSTA MESA, CALIFORNIA

Circle 659 on Page 35

which are then passed through mechanical rolls. A subsequent heating brings the sheets to required density. The International Silver Co., through its sponsorship of research work at the Powder Metallurgy Laboratory, assisted in the inception of certain phases of the proposed new method.

Penton Elects Vice President-Editorial

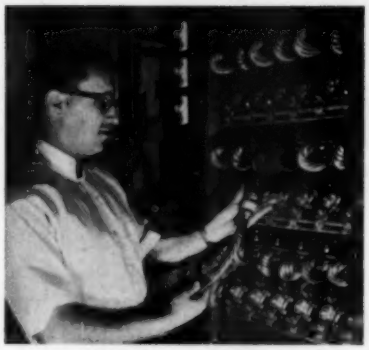
PUBLISHERS of AUTOMATION, the Penton Publishing Co., has announced the election of **Irwin H. Such** Vice President-Editorial at a recent meeting of the Board of Directors. He was previously editor-in-chief of *Steel* magazine, also a Penton publication. In his new position, Mr. Such will devote much of his time to editorial field contact, acting in an editorial liaison capacity between Penton publications and as a consultant to them. Other Penton publications besides AUTOMATION and *Steel* are: *Machine Design, Foundry* and *New Equipment Digest.*

Mr. Such has been with Penton in various editorial capacities since 1928. He is a past president of the Society of Business Magazine Editors, and a member of the National Press Club of Washington, Press Club of Cleveland, American Society for Metals, American Welding Society, Association of Iron & Steel Engineers, Delta Kappa Epsilon, and Sigma Delta Chi (Professional Journalistic Fraternity).

FOR ADVANCING the professional status of the consulting engineers profession, the 1960 Merit Award of the Consulting Engineers Council was presented to Minneapolis-Honeywell Regulator Co. for its recent advertising campaign. Presentation was made at the November semiannual meeting of the Council's board of directors in Pittsburgh.

Handling System Pumps Cement Through Hose

DRY BULK CEMENT is pumped through a special hose from tank trucks somewhat like those that haul gasoline. The hose, manufactured by B. F. Goodrich Industrial Products Co., has a 4-inch ID lined with a tough rubber that resists abrasion from flying cement particles. The truck tank is divided horizontally by a woven canvas wall. The top compartment can hold up to 800 cu ft of dry cement, but the lower compartment is left empty. While the canvas is strong enough to support the cement, it is sufficiently porous to permit passage of air under pressure. When air is forced into the empty lower compartment, it passes through the canvas and out the delivery hose carrying cement at a rate of 5 barrels a minute. A full load can be discharged in less than 30 minutes.

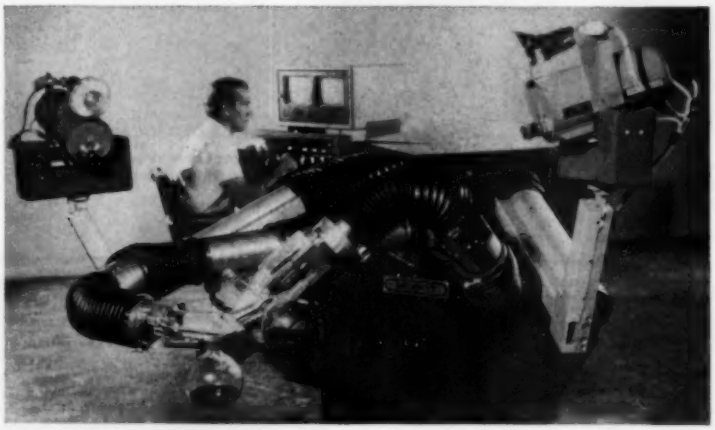


INDUSTRIAL RECTIFIER of 300 kw capacity using experimental high-current silicon-Trinistor controlled rectifiers has been built by Westinghouse Electric Corp.'s rectifier and traction equipment department. This prototype model will supply 1200 amps continuously, 1500 amps for 2 hours, or 2400 amps for 10 seconds. Output voltage is 250 v. Circuit used is six-phase, double wye. Westinghouse designer Willard Albert (shown here) was responsible for the development of the new unit.

PNEUMATIC DIGITAL COMPUTER is under development by Kearfott Div., General Precision Inc. For certain applications, it is expected to be able to do everything an electronic or mechanical computer can do. It will operate in temperatures from −100 to 2000 F without special provisions for heating or cooling. Heart of this computer is a bistable element, or flip-flop, which operates on compressed air or gas, and which has a switching time of ten millionths of a second.

Electric Furnace To Produce Bottle Glass

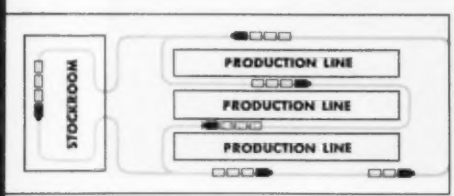
FIRST ALL-ELECTRIC furnace to produce bottle glass in the United States is being installed at Chattanooga Glass Co., subsidiary, Dorsey Corp. In foreign countries there are several all-electric fur-



REMOTE-CONTROLLED mobile handling device was built by Hughes Aircraft Co. for use in areas too dangerous for men to work. Device has three joints in each arm—at shoulder, elbow, and wrist, and is double-jointed in each joint. It is strong enough to lift a lead brick and delicate enough to replace a light bulb. The light touch stems from the soft inflated pads on its hands in which the pressure can be delicately controlled by its human operator. In the illustration, the handling device shows its light touch by preparing to pour liquid chemical from one flask to another under the command of the operator at a control console. Two television cameras focus on the work the hands are performing and transmit a picture to the control console. The operator can direct actions from a safe position more than 100 feet away, even from another room. Microphones at the wrists permit the operator to hear the tasks the machine's hands perform.

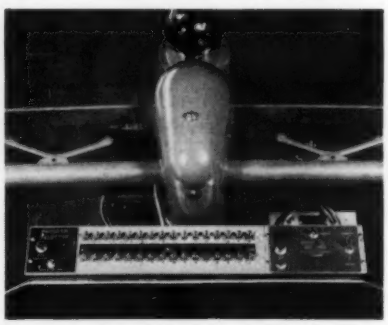
Barrett driverless GUIDE-O-

This typical Guide-O-Matic tractor installation slashes material movement costs. Among scores of Guide-O-Matic system installations, here's a recent one utilizing nine driverless tractors in the warehouse of a large automobile manufacturer. The Guide-O-Matic control system permits more than 50 preset stops throughout the huge plant building.

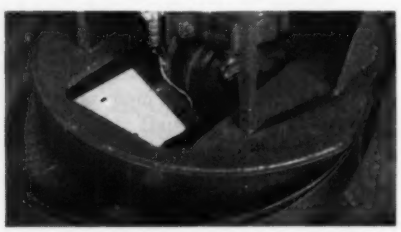


Move anything, go anywhere—better, faster. No matter what you move in your plant or warehouse—or where—Guide-O-Matic movement can save time, effort, money. Close to 100 installations demonstrate this—some like the layouts above, others considerably different. Movement may be short distances or long, indoors or out, over level surfaces or up and down ramps or grades. Installations may include only a few tractors, or a dozen or more.

There is nothing like Guide-O-Matic—nothing as thoroughly tested, tried and proved—no experience in automated material movement systems as long and complete as Barrett's.



Your finger does the work! With Guide-O-Matic systems you control material movement by flicking switches. You preselect stops before the tractor starts on its route. Simple to reset. Controls may be on the vehicle or at central control point. Programming panel is used for multiple systems.



Positive, precise control—electronically. A Guide-O-Matic vehicle follows either a guide wire embedded in the floor, or a painted line or tape. With guide wire, sensing unit is magnetic; with painted line, optical. Vehicle *cannot* stray. Stops are controlled by "beacon" points; starts, by automatic timing or by switching.

The control units illustrated above actually identify Guide-O-Matic. This in turn controls a Barrett tractor. Guide-O-Matic control is far from limited to tractors—may control lift-trucks, cranes or other equipment.

automated material handling systems

...what they do! ...how they work!

Some people still consider Guide-O-Matic almost like magic. You flick switches. Vehicles go to work by themselves, following guide lines in the floor. Down narrow aisles. Around sharp corners. Stop on a dime, at your bidding. Absolutely accurate, reliable, unemotional. Amazingly efficient.

The big news today is the success of Guide-O-Matic systems. Developed seven years ago, Guide-O-Matic is moving into plant after plant—slashing costs, boosting productivity.

The Guide-O-Matic operator controls driverless vehicles by pushing buttons or switches. For example, tractors follow planned routes, balanced to the material flow laid out by engineers. Preset controls stop or start movement where desired along the route.

Operation requires only a fraction of the time required to run manned equipment. *Thus, almost all operational cost is eliminated!*

This precise, positive control speeds operations all along the line. Removes inefficiencies. Keeps production flowing on exact schedules. *Increases plant productivity by as much as 40%.*

Certainly Guide-O-Matic is big news. Worth your thorough investigation now.

write for complete information-Now!

PLANTRONICS DIVISION
BARRETT-CRAVENS COMPANY
654 Dundee Road • Northbrook, Illinois

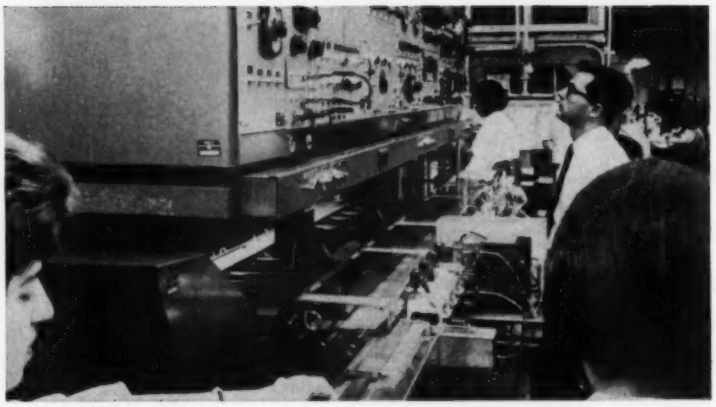
Barrett Handling Equipment

BARRETT

GUIDE-O-MATIC *YOUR SUREST LINE OF PROGRESS*

Circle 660 on Page 35

naces in glass container plants. The new furnace is expected to increase production capacity by approximately 20 per cent over fuel-burning furnaces, melting 60 tons of raw materials into glass every 24 hours. Other features include production of better quality glass, shorter repair time, and requirement of a smaller space for installation.

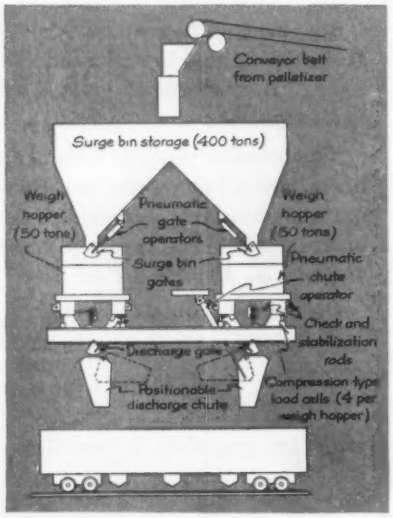


MASS PRODUCTION of second generation transistors and other semiconductor devices is an automatic operation at the new $3,000,000 plant of the Semiconductor Div., General Instrument Corp., at Hicksville, L. I., N. Y. In the illustration, carrier blocks holding tiny wafers of germanium are fed to a transfer arrangement that takes them through an electronically-controlled automatic etching process.

Counters Control Flow of Mail

CONVEYORIZED "Mail-Flo" system has been installed in a number of post offices to automatically feed, control, and keep an inventory of trays of mail being processed. The system was designed by Cutler-Hammer Inc. A perpetual inventory of the mail trays in process and in storage is kept by electric remote control counters which are actuated by limit switches placed on the conveyor lines. The counters used in the system were made by Durant Mfg. Co. Electronically controlled stops hold the trays in temporary storage until called for to service work stations on demand. A button is pressed to release the trays, another designates how many trays are wanted, and a third selects the aisle where the trays are to go.

RELIEVING the average-size manufacturer of the task of tabulating inventory, sales, pricing, invoice, personnel, and other records is the function of the Statistical Tabulating Corp. which has added a fourteenth bureau to its nationwide network. The new bureau has been added in Dallas by the acquisition of Rutherford Business Service. The service bureau tabulates and computes records and processes data for activities such as sales analysis, accounts receivable and payable, market research, and industry-wide statistics. The firm operates computer centers in Chicago, New York, and Los Angeles, with a fourth to open soon in Dallas.



LOADOUT HOPPER SYSTEM for pelletized iron ore electronically weighs, records, and loads railroad cars. Designed by Gilmore Industries Inc., the system consists of two weigh hoppers with gates and actuating equipment, a complete instrumentation package, and a calibration system. The pellets are fed into two surge bins which permit a continuous flow from the pelletizer while the weigh hoppers are statically weighing material. Each weigh hopper is mounted on four 50,000 lb compression load cells. Check rods and stabilizing rods insure that only vertical loads are placed on the load cells. Material is dumped from the weigh hoppers into a railroad car by positionable discharge chutes which are pneumatically operated by control signals from the instrumentation system. The instrumentation system prints on a paper tape the net weights delivered to each railroad car and accumulates car weights to obtain the total train weight.

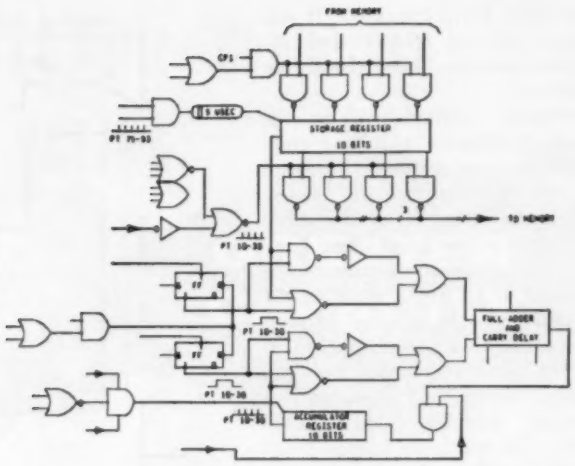
Instrument Detects Weather Conditions

SENSING DEVICE detects snow, freezing rain, hail, or ice conditions. Designed by Rails Co., the device consists of a sensing head, temperature control, and control box. When moisture from snowfall, freezing rain, etc., collects on the sensing head, it energizes a relay, by means of a transistorized amplifier in the control box, if the temperature is below that set on the thermostat. The temperature control indicator is set to the highest temperature desired for the snow detector to be effective (usually around 38-40F). The sensing head is a metallic grid which is always heated and will constantly clear itself of moisture.

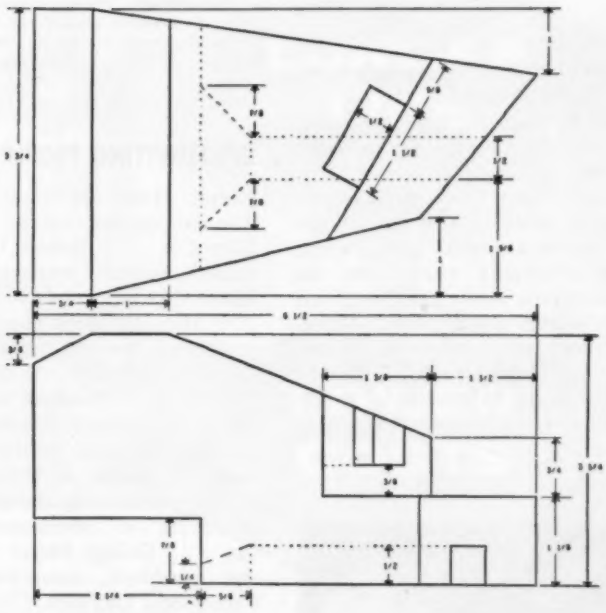
Painted Coil Capacity Expanded

MAJOR EXPANSION of facilities to produce painted coil is underway at Kaiser Aluminum & Chemical Corp. plant in Ravenswood, W. Va. The new paint line, capable of handling coil in gages ranging from 0.006 to 0.064 inches, is expected to be in operation by midsummer of 1961. Equipment to coat aluminum in widths up to

NOW! Automatic drafting like this from your computer in less than 1 second!



Actual drawings produced by the S-C 4020 High-Speed Microfilm Recorder



The S-C 4020

Instantaneous mechanical drawing is now a reality, with the Stromberg-Carlson S-C 4020 High-Speed Microfilm Recorder. Automatic drafting can cut weeks from design time, saving invaluable engineering man-hours. Here's how it works:

A computer is programmed with the contours and specifications of the part to be designed, using APT (Automatically Programmed Tool) language. The computer operates the S-C 4020 Recorder which makes multi-view mechanical drawings of the part in a fraction of a second. After the drawings have been checked, output of the computer can be used to operate a numerical control tool and produce the part. Capabilities of the S-C 4020 include recording data on microfilm at 17,500 points per second, plotting graphs on microfilm at 12,500 points per second, recording complex logic circuit drawings, tabular printing and forms projection. Write for more details to Stromberg-Carlson-San Diego, Dept. B-25, P. O. Box 2449, San Diego 12, California.

STROMBERG-CARLSON-SAN DIEGO
A DIVISION OF **GENERAL DYNAMICS CORPORATION**

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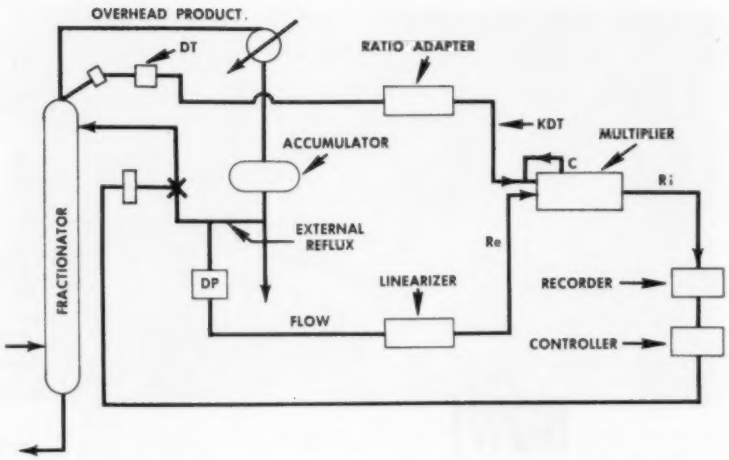
48 inches is being installed. It will augment existing 66-inch and 18-inch roll coating lines already in operation.

Producing painted coil on the 48-inch equipment will be a completely automatic operation, with the metal passing through 14 separate steps. Because of the automatic cycle of the paint lines, quality of the coated aluminum coil is controlled at all times, allowing the end product to be adapted to present conventional forming methods such as bending, brake and roll forming, crimping, blanking or flattening, without damaging the finish. The coil stock will be available in a wide variety of colors in newest types of paints.

NEW SEAL for steel strapping combines high joint strength with high impact resistance. It was designed by Signode Steel Strapping Co., and is suitable for painted, painted and waxed, or waxed Magnus and Heavy Duty strapping in 1¼-inch widths. Strength of the seal lies in a special high friction mastic compound which coats the inside surface in the area in which the crimping action occurs. When the crimps are applied, the mastic compound bites through slippery strap coatings to provide a strong frictional bond between the metal surfaces.

MOBILE data handling system known as Radac I, has been introduced by Radiation Inc. Housed in a mobile enclosure four feet high, the unit will collect critical data on variables that must be measured during processing and production. It can process and prepare this information on magnetic tape for direct entry into most common computers. The system includes a high-speed programmable multiplexer, an analog to digital coder, digital standard logic circuits, a digital tape transport, and power supplies.

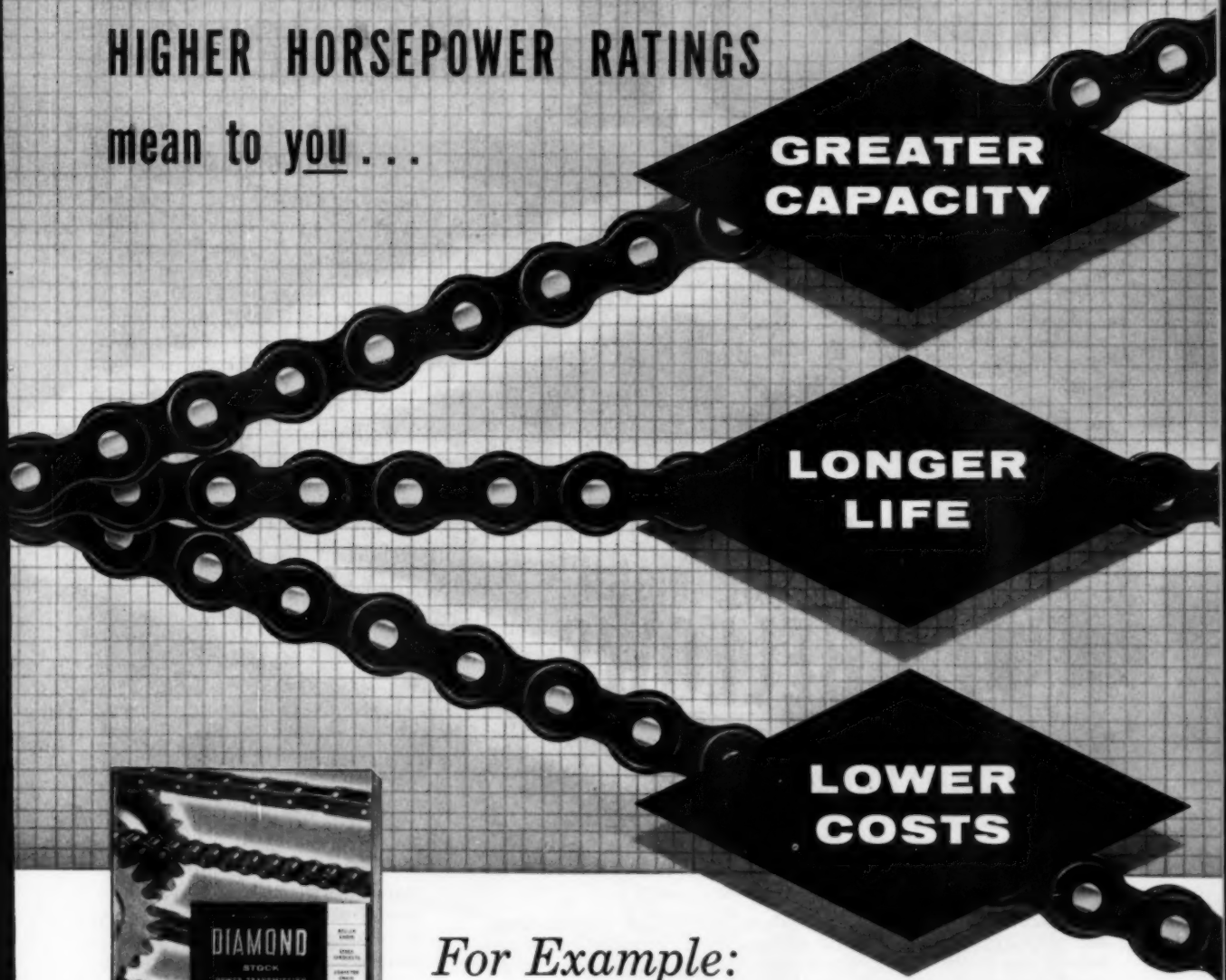


FRACTIONATOR control system computes internal-reflux flow and keeps it constant, preventing column upsets due to the effect of ambient-temperature changes on external reflux. The controller, developed by Swartwout Div., Crane Co., computes internal reflux flow from measurements of the external-reflux flow rate and the difference in temperature between overhead product and the external reflux. Constant internal-reflux flow is maintained by regulating a valve on the external-reflux stream. The block diagram illustrates major control units in a fractionating tower arrangement.

SPOTLIGHTING PEOPLE

Joseph Hauf appointed technical director—engineering, for the E. W. Bliss Co. . . . **Robert D. Calvert** named general manager of the Electro-Mechanical Div., Lear Inc. . . . **Alton W. Beck** appointed vice president, western operations at Robertshaw-Fulton Controls Co. . . . **Frank E. Hibbard** named Pacific Coast regional manager for Industrial Controls Section, Bendix Corp. . . . **Robert A. Trumpis** elected vice president in charge of manufacturing at Minneapolis-Moline Co. . . . **George Meyer** appointed vice president, manufacturing at Parker Seal Co., Div., Parker-Hannifin Corp. . . . **Daniel C. McCarthy** elected executive vice president of Pratt & Whitney Co. Inc. . . . **J. N. Marshall** appointed manager, advanced systems development engineering of the Electronic Data Processing Div., Radio Corp. of America. . . . **Jack K. Walker** joined Packard Bell Electronics as director of product planning for the Defense and Industrial Group. . . . **John W. Haanstra** promoted to vice president of the General Products Div., International Business Machines Corp. . . . **James E. Maloney** named research supervisor of the Chemical Processing Div., Detrex Chemical Industries Inc. . . . **William T. Blake** appointed assistant chief of production engineering at Fischer & Porter Co. . . . **J. W. Palmer** promoted to general manager of the Cast-Master Div., Hydraulic Press Manufacturing Co. . . . **Russell P. Hook** named chief engineer of the Machine Tool Div., Norton Co. . . . **Robert F. Moody,** general sales manager of Hyster Co., elected president of the Material Handling Institute Inc. . . . **Jesse Daugherty** appointed to the board of directors of the Giddings & Lewis Machine Tool Co. . . . **Claude T. Gurley** named product manager for data collection and processing systems at Control Data Corp. . . . **L. D. T. Berg,** manager of the Equipment Marketing Dept. of Air Reduction Sales Co. elected chairman of the arc welding section of the National Electrical Manufacturers Association. . . . **William J. Edmunds** appointed general manager of the industrial division of Kaiser Aluminum & Chemical Corp. . . . **John E. Lucas** elected president and chief executive officer of VHM Corp. . . . **Richard L. Chaltry** appointed chief engineer at Milwaukee Cylinder Co. . . . **Paul R. Hartig** elected vice president and general manager of the Yale Materials Handling Div. of Yale & Towne Mfg. Co. . . . **Warren D. Hulbert** named manufacturing manager for trimming potentiometers at Spectro Electronics Corp. . . . **Thomas Meloy** elected chairman of the board and **Edward M. Bostick**

Here's what DIAMOND Roller Chain's HIGHER HORSEPOWER RATINGS mean to you . . .



Write for New DIAMOND CATALOG No. 760

Just off the press. DIAMOND Stock Roller Chain, Sprocket, and Coupling Catalog No. 760 gives all the new horsepower ratings. Catalog 760 also contains full data on four important new DIAMOND Roller Chain Products: *Micropitch, Dura-Weld* and *Tuf-Flex* chains and *Hi-Cap* flexible couplings.

For Example:

Former ratings for 1 inch pitch roller chain permitted sprocket speeds up to 1160 RPM, whereas the *new* ratings include speeds up to 2800 RPM. Similarly, rated *horsepower* capacities formerly did not exceed 49 HP, whereas the new ratings exceed 150 HP. New, higher ratings mean that DIAMOND roller chains are capable of more work, will last longer (thus, cost less to operate) than heretofore considered practical. You now have more opportunities to specify high-efficiency DIAMOND Roller Chain drives . . . both in new equipment designs and in modifications of existing equipment. Write today for *new* DIAMOND Catalog No. 760. *It contains all the new ratings* as established by the Association of Roller and Silent Chain Manufacturers, of which DIAMOND is a charter member.

DIAMOND CHAIN COMPANY, INC.
A Subsidiary of American Steel Foundries
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Offices and Distributors in all Principal Cities

DIAMOND ROLLER CHAINS ®

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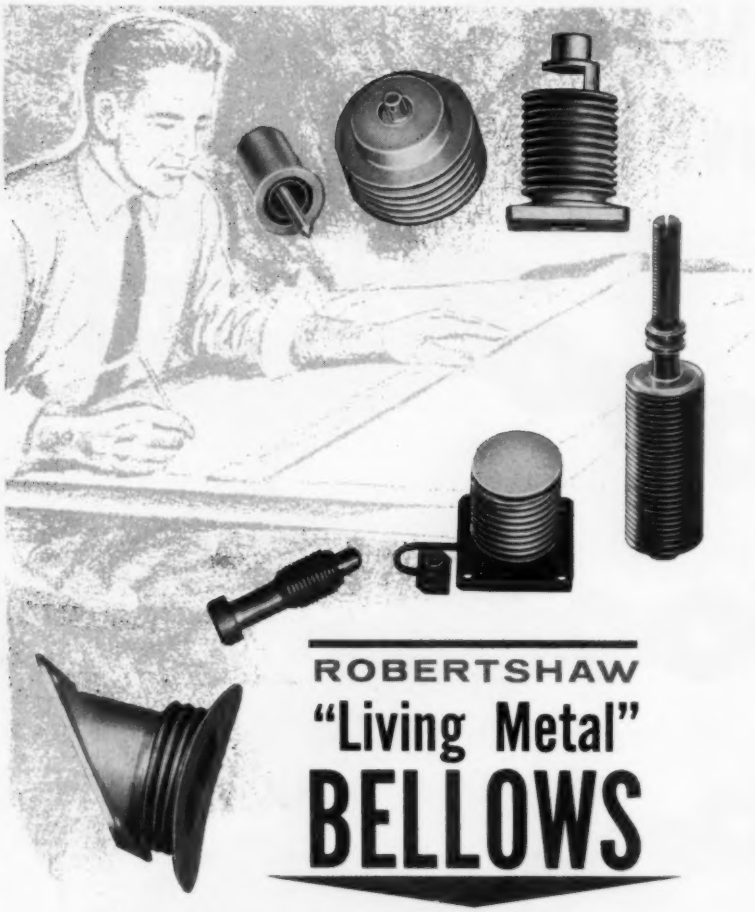


. . . "the Design Engineer's Most Versatile Aid!"

The quote comes from an engineer who's seen it proved again and again . . . where critical requirements demand a flexible connector or expansible tubing that would stand up under extremes of temperature, pressure or atmosphere.

Exceedingly versatile, Robertshaw bellows are custom-engineered to specific needs . . . and are available as complete, pre-tested *bellows assemblies* that save you time, trouble, expense . . . to get your finished product on the road, in the air or into space quicker and at highest efficiency.

Every Robertshaw bellows is backed by the most experienced know-how in the field. We built the first seamless metal bellows; and we're still building the best . . . in inconel, inconel-X, beryllium copper, brass, phospher bronze, monel, stainless steel and Ni-Span-C.

There's a world of information on bellows versatility in our comprehensive Catalog EK-R. Write for it today.

Robertshaw

MR. CONTROLS

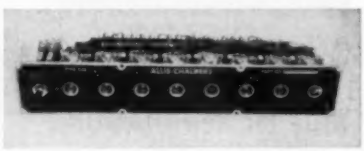
Robertshaw-Fulton Controls Company

FULTON SYLPHON DIVISION, KNOXVILLE 1, TENNESSEE

elected president and chief executive officer, both at Melpar Inc. . . . **Lester F. Beers** joined Tri-Point Plastics Inc. as project engineer . . . **Joseph A. Cutler** named chairman of the board and **Richard J. Murphy** appointed president, both at Johnson Service Co. . . .

SPOTLIGHTING PLANTS

General Electric Co. announced plans for a four million dollar addition to its Computer Dept. in Phoenix. The new expansion will add approximately 190,000 sq ft to the existing 204,000 sq ft manufacturing and administrative building. . . . **Square D Co.** has purchased from Gorham Mfg. Co. a 98,000 sq ft plant located on 35 acres on the outskirts of Asheville, N. C. The plant will serve as headquarters for the company's Commercial Control Div. . . . **Convair Div., General Dynamics Corp.** is moving its Dynapak facility from Pomona to San Diego. The division manufactures high-energy-rate metal forming machines and a line of advanced mechanical test equipment. . . . **Beckman Instruments Inc.** has begun construction of a new $1,250,000 building to house its Systems Div. at the Fullerton, Calif. headquarters plant. The division specializes in the development and manufacture of high-speed electronic data processing systems. . . . **American Systems Inc.** is the name of a new firm organized for the research, development, and manufacture of advanced electronic systems. It is located in Hawthorne, Calif. and has divisions for electromag-

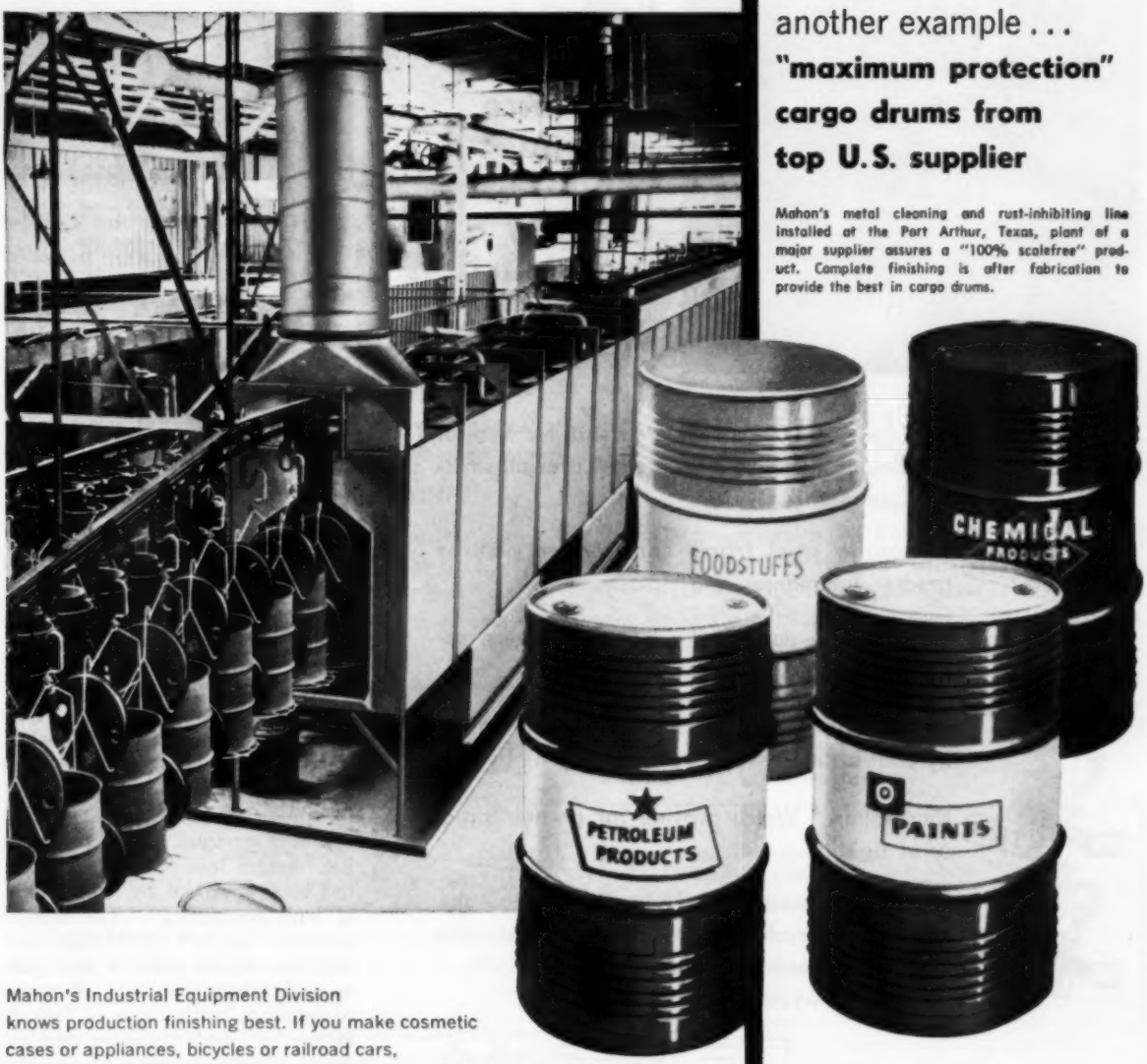


MEMORY TYPE fault detector, for use in the operation of complicated mill control systems, has been developed by Allis-Chalmers Mfg. Co. Instrument consists of a transistor, silicon controlled rectifier, capacitor, and neon light circuit with a readily alterable time delay to prevent false indications in case of contact bounce in the circuit being monitored. The detector is arranged so that any change in state beyond the time delay interval in the monitored circuit will trigger the controlled rectifier and turn on a high intensity incandescent light.

Circle 663 on Page 35

Quality metal products deserve

"the finishing touch" of Mahon



another example . . .

"maximum protection" cargo drums from top U.S. supplier

Mahon's metal cleaning and rust-inhibiting line installed at the Port Arthur, Texas, plant of a major supplier assures a "100% scalefree" product. Complete finishing is after fabrication to provide the best in cargo drums.

Mahon's Industrial Equipment Division knows production finishing best. If you make cosmetic cases or appliances, bicycles or railroad cars, or any other metal product . . . and if quality comes first . . . call in Mahon. Improved finishing can be the easiest and most economical product improvement you'll ever make. New paints, new methods broaden the possibilities. Find out what the 'finishing touch' of Mahon can do with your products . . . your costs . . . your sales. Get in 'touch' with Mahon.

MAHON INDUSTRIAL EQUIPMENT

• Finishing Systems • Metal Cleaning Equipment • Painting Facilities—spray, dip and flo-coaters • Drying and Processing Ovens • Special Plant and Production Equipment

WRITE FOR MAHON CATALOG A-661
ALSO IN SWEET'S P. E. FILE

THE R. C. MAHON COMPANY
DETROIT 34, MICHIGAN
MANUFACTURING PLANTS—
Detroit, Michigan and Torrance, California
SALES-ENGINEERING OFFICES—Detroit, New York, Chicago, San Francisco and Torrance.

YOUR BIGGEST VALUE IS IN MAHON'S PLANNING & ENGINEERING EXPERIENCE

MAHON

Circle 664 on Page 35

EMCOR® Standard Cabinets

offer more EXTRA advance design and quality construction features!

EXTRA 7" high, 16 gauge steel center strut for ease of equipment mounting and greater over-all structural strength.

EXTRA 14 gauge steel frame construction assures greater ruggedness and rigidity.

EXTRA Electronically controlled spot welds assure superior strength.

Jig assembly line fabrication provides rigid quality control and assures compatibility of frames.

EXTRA Key Heliarc* Welds provide for greater structural rigidity.

EXTRA Continuing research and development by the Roy C. Ingersoll Research Center maintains EMCOR leadership in metal cabinetry.

*Registered Trademark Linde Air Products Co.

From single cabinets to major systems, the hundreds of basic frames of the EMCOR Modular Enclosure System meet your height, width, depth and structural enclosure needs.

WRITE TODAY FOR CONDENSED CATALOG 106

Originators of the Modular Enclosure System

INGERSOLL PRODUCTS

Division of Borg-Warner Corporation

630 CONGDON • DEPT. 1231 • ELGIN, ILLINOIS

BORG-WARNER

ADJUSTABLE SAFETY PRESS block to reduce accident potential and shorten downtime of power presses has been developed by Duff-Norton Co. The safety device is a modified version of the bell base screw jack. It is attached to the press with a short length of chain and a safety plug. The plug must be removed from its position in the power control panel before the safety device can be used. Once the plug is removed, all power to the press is automatically cut off, but returning the plug to its position, allows the press to be actuated.

netic systems, information sciences, solid-state research, command and control systems, and advanced component development. . . . **Consolidated Electrodynamics Corp., subsidiary, Bell & Howell Co.** has combined its Data Tape Div. and Electro Mechanical Instrument Div. into a single operation to be called the Data Recorders Div. Purpose of the merger is to increase manufacturing efficiency, and improve customer service. . . . **Jack & Heintz Inc.** merger into the **Siegler Corp.** has been approved by stockholders of both companies. The merger combines Siegler's capabilities, as a manufacturer of military and commercial electronics and aerospace components, with those of Jack & Heintz in missile, aviation, and industrial fields, forming a company with annual sales of approximately $100 million. . . . **Electronic Data Processing Div., Minneapolis-Honeywell Regulator Co.** has announced construction plans for a plant at Lowell, Mass. to manufacture components for EDP systems. The new building will occupy 54,000 sq ft of floor space in a nine-story building. . . . **National Automatic Tool Co.** has purchased the Bucyrus-Erie Co. plant in Richmond, Ind. and will move there from its present Richmond

Now... Sylvania cuts the price of automation

New, compact 44-station automatic transfer machine brings the benefits of automation within reach of most manufacturers.

It's about half the size of other top-quality transfer machines, far less expensive, too. What's more, it dovetails neatly into the trend to smaller and smaller products and assemblies by providing more stations per foot.

It's a machine that could be ideal for you if you make any product that involves several station-to-station operations.

WHAT IS A TRANSFER MACHINE?

It's automation's basic building block. It moves pieces-in-production from one tool or worker to another, stops the piece long enough so it can be bent, drilled, tapped, heated, measured, molded, riveted, coated, assembled, packaged, etc.

Sylvania makes several models of these basic machines. And if you do not have facilities, we can recommend reliable and experienced manufacturers of the necessary tools, jigs, etc., which you'll need in your automation program.

HOW TO AUTOMATE

That's a tough one. It varies almost with each manufacturing operation. Sylvania will provide free consultation to help with your particular problem but, in any event, there's one basic rule for almost every situation: *You must start with the best transfer machines if you're going to realize the full benefits of automation.*

Naturally, you pay more for the best. But a good transfer machine can last for 30 years or more. What's more, by changing tools and jigs, it can be adapted to almost any conceivable production operation. You can even change products without changing transfer machines.

WHERE TO BUY

Naturally, we're a bit biased, but we believe Sylvania transfer machines are the best on the market.

We've been building them for our own use for over 20 years, because we have never been able to buy one that met our accuracy standards for the manufacture of lamps, tubes, fine electronics equipment.

We make two general types—Rotary indexing chassis and Conveyor indexing chassis. Both have many exclusive features which contribute to their outstanding performance. And we also make 5 models of precision indexing transmissions of superior quality.

FREE HELP—AND INFORMATION. If you're thinking of automating, we'd be glad to have one of our automation sales engineers call on you with his suggestions and advice. Or, if you'd like more details on Sylvania transfer machines, send for our free brochure.

SYLVANIA LIGHTING PRODUCTS
Equipment Development Plant
121 Loring Avenue, Salem, Mass.

Please send me free brochure of:

☐ Rotary ☐ 44-Station Conveyor and 80-Station Conveyor ☐ Transmissions

Name_____

Position_____

Company_____

Address_____

City_____ Zone_____ State_____

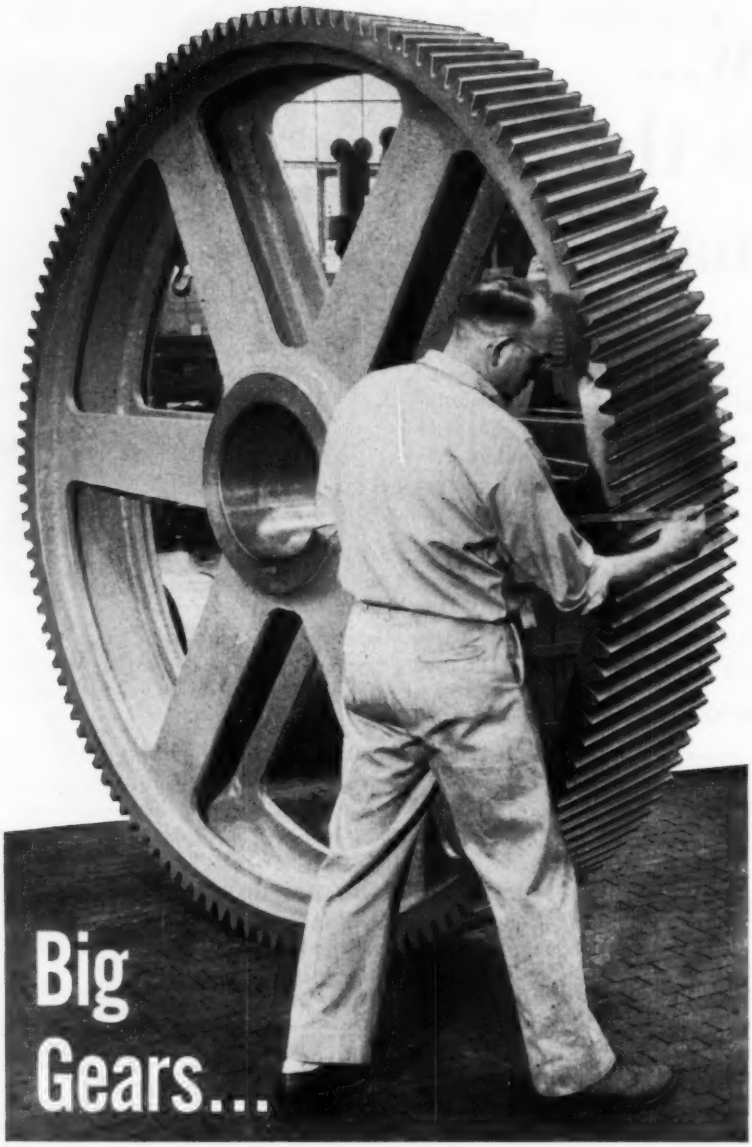
☐ PLEASE HAVE SALES ENGINEER CALL FOR APPOINTMENT

SYLVANIA

SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

Circle 666 on Page 35



fast delivery on custom requirements

SPUR • HERRINGBONE • HELICAL

Horsburgh & Scott specializes in fast production of quality industrial gearing . . .

Gears engineered to meet custom requirements in a wide range, from small to large sizes.

Speed Reducers produced in standard types and special drives for fast custom delivery.

Send your specifications, or let our technical staff make recommendations.

Write for Catalog FLB-60

The HORSBURGH & SCOTT CO.

5112 Hamilton Avenue • Cleveland 14, Ohio

Manufacturers of Gears and Speed Reducers for over 75 years

location. The plant is located on a 147 acre site, has 365,000 sq ft of floor space. . . . **Pomona Div., Marquardt Corp.** has moved into a new 27,500 sq ft enigneering building. The division develops and produces electronic test and checkout equipment, data simulators, and security devices. . . . **Ohio Seamless Tube, Div., Copperweld Steel Co.** is constructing an all-steel building that will house two new electric welded tube mills. The new mills will produce both round and special shaped welded tubing in heavier wall thicknesses and in diameters up to 7½ inches. . . . **Litton Systems Inc., Div., Litton Industries** has acquired Applied Communication Systems, Div., Science Research Associates Inc., developer and manufacturer of specialized audio-visual equipment. The group will operate as a division of Litton Systems. . . . **AutoSonics Inc.** is the name of a new company formed to design, manufacture, and distribute an automated cleaning machine which uses ultrasonics. It will also produce conventional industrial cleaning equipment and paint finishing systems. . . . **Dow Chemical Co.** has formed a new laboratory to be known as the Instrument Systems Research Laboratory. Purpose of the laboratory will be to assist all company personnel including research, engineering, and production groups with problems relating to instruments and instrument applications.

AUTOMATIC merchandising machine which dispenses packaged clothing items is being tested at a Montgomery Ward catalog store. Merchandise used for the test is a selection of men's underclothing. The machine accepts any amount of money up to $9.00, in any combination of coins, $1 and $5 bills. When the money is inserted, the machine visually records the total amount paid in. The proper change is returned when the customer completes his purchases.

Circle 667 on Page 35

CONTROL DENSITY and FLOW RATE of ON-STREAM LIQUIDS

...automatically!

Now liquid density and flow rate can be automatically controlled by these new Halliburton instruments ... the FLOW METER and DENSOMETER. Here are the details:

HALLIBURTON DENSOMETER is a direct acting instrument designed to continuously measure and record fluid density of the product passing through it. Variances in product density are signaled from the device to automatic valves which alter component input maintaining densities at pre-set levels. Operation of the Densometer in measuring density is completely independent of other fluid characteristics such as velocity, viscosity, pressure, etc. The Densometer is designed to maintain an accuracy of ±1%.

HALLIBURTON FLOW METER is an in-line device equipped with a flow-actuated turbine with long-life bearings. As fluid entry rotates the turbine, electronic pulses generated are routed to key up-line motor valves which maintain the flow rate at pre-set quantities. This inexpensive instrument requires no lubrication and is available in 1", 2", 4", 6", and 8" models with any end connections desired. Accuracy of the Flow Meter is designed for ±1%.

Other Halliburton Products for Automated Industries

NEW Pneumatic-Electrical Control Panel for Bulk Material Handling Equipment provides the operator with finger-tip remote control over flow line valves and motivating air supply valves.

POSITIVE SEAL Full Opening LO-TORQ PLUG VALVE with *teflon-insert* seals gas lines *bubble-tight* in high-pressure applications. Available in 1" to 3" sizes for working pressures from 1,000 to 15,000 psi equipped with threaded, flanged or scarfed end connections.

For more information on any of these outstanding new developments for automation, see your Halliburton man, or write direct to:

moving ahead
through research
and engineering

SPECIAL PRODUCTS DIVISION

Halliburton
COMPANY · DUNCAN, OKLAHOMA

Circle 668 on Page 35

INFRARED

IN...ON...OVER...UNDER...AROUND—FOSTORIA OVENS BAKE FINISHES FAST REGARDLESS OF PRODUCT SHAPE

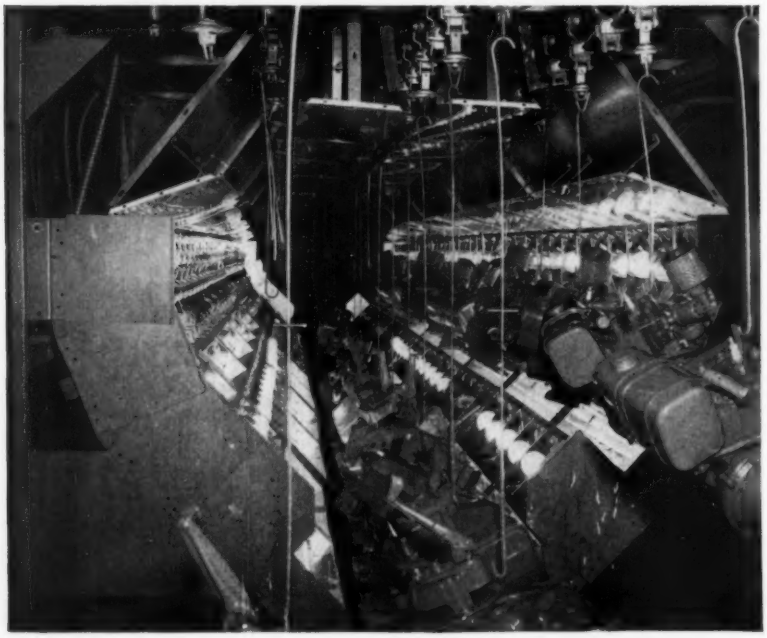
Irregular product contours and varying metal thicknesses make it tough to properly bake enamel finishes uniformly. Runs, soft spots, thin spots and over baking are commonplace, resulting in poor appearance and customer dissatisfaction. But Clinton Engines Corporation of Maquoketa, Iowa and Clinton, Michigan have solved the problem with the pictured installation of Fostoria Infrared Drying Ovens.

Because Fostoria Infrared ovens are designed to direct heat to **all** surfaces evenly and quickly, Clinton engineers find 50% fewer rejects due to improper finishing. In addition, they have cut drying time by 50%. They are saving 15% on paint material costs.

As though this weren't enough, they are finding equally successful results on such diversely shaped products as engines, chain saws and outboard motors.

Damage, due to production line stoppage, has been practically eliminated because, in contrast to hot air equipment, infrared heat peaks and shuts off almost instantly.

This is only part of the story. Innumerable progressive manufacturers in such diverse industries as metalworking, wood, paper, textiles, food and many others are using Fostoria Infrared Ovens to bake, dry, cook, dehydrate, and perform other heat processing applications—in short to produce better products at lower cost. Case histories are available to you without charge. Write today, giving a brief description of your type of manufacturing and we'll send pertinent information as to how Infrared can benefit you.



FOSTORIA

INFRARED DIVISION • FOSTORIA CORPORATION • FOSTORIA, OHIO

GREEN-COLORED rubber conveyor belts used in food processing operations highlight color variations in ears of corn, making grading easier and faster. Also, compounds in the belt retard the growth of bacteria and mold. The belts, manufactured by B. F. Goodrich Industrial Products Co., do not absorb moisture and minimize stretching or shrinkage adjustment. With the rubber belts, cleaning time is reduced, since they need only be hosed down three times a day and scrubbed once at the end of each season, in comparison with former belts which had to be laboriously scrubbed every week.

MEETINGS & EVENTS

Mar. 6-8—

American Management Association Data Processing Conference. Exhibit and conference to be held at the Statler Hilton Hotel, New York. More information from association headquarters, 1515 Broadway, Times Square, New York 36, N. Y.

Mar. 8-9—

Instrument Society of America. Conference on instrumentation for the iron and steel industry to be held at the Pick-Roosevelt Hotel, Pittsburgh. Cosponsored by the Metals and Ceramics Industry Div. and the Pittsburgh section of the ISA. Information available from A. W. Dudreck, College & Pike, Canonsburg, Pa.

Mar. 13-17—

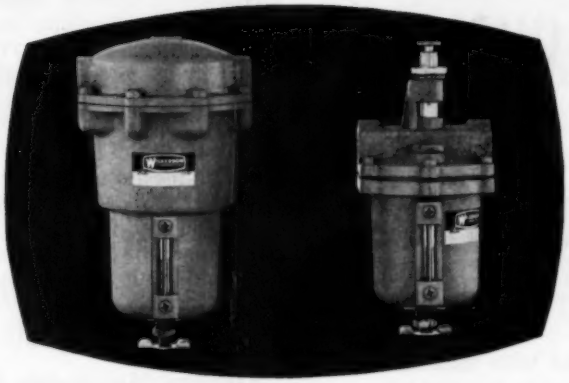
Society of Automotive Engineers. National automotive and production meeting to be held at the Sheraton-Cadillac Hotel, Detroit. Additional information from society headquarters, 485 Lexington Ave., New York 17, N. Y.

Mar. 16-17—

American Society of Mechanical Engineers. Textile engineering conference to be held at Clemson College, Clemson, S. C. More informa-

NOW . . . OBSOLETE!

Plastic bowls and bowl guards on air line products are



NEW

WILKERSON SAF-T-BOWLS

Now available on compressed air filters and lubricators for visible water and oil level

Eliminates the hazards of exploding bowl due to high pressure, high temperature, cleaning solvents, steam cleaning, chemical oils and impact

EXCLUSIVE! MAXIMUM VISIBILITY

Full 230° visibility . . . and bowl can be rotated so gauge is in any position for easy, safe viewing. Thin metal bar in center protects heavy pyrex sight gauge from impact without interfering with visibility.

EXCLUSIVE! **REPLACEMENT SAVINGS!**
WILKERSON SAF-T-BOWL is interchangeable with existing plastic bowl units.

EXCLUSIVE! **FURTHER SAVINGS!**
Sight glass can be ordered separately and installed on existing metal bowl units.

EXCLUSIVE! **ALL SIZES!**
Available on ¼" to 2" P. T. Filters and Lubricators.

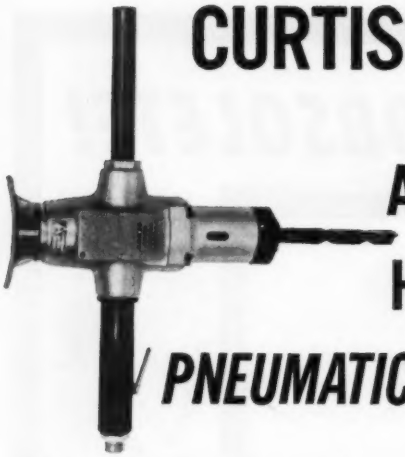
WRITE TODAY for Circular #1041 which gives complete information on the *NEW* Wilkerson SAF-T-BOWL.

1552 W. MANSFIELD, ENGLEWOOD, COLORADO

WILKERSON CORPORATION

Dedicated to keeping the NEW in pNEUmatics

Circle 670 on Page 35



CURTISS-WRIGHT

ANNOUNCES

A NEW LINE OF HIGH QUALITY PNEUMATICALLY OPERATED HAND TOOLS

PNEUMATIC DRILLS — Sizes from ¼" to 1¼". Weight, ½ to ⅓ as much as comparable electric drills. Easily controlled speed, for slow starts without pre-centering.

Precision designed, pneumatically operated hand tools manufactured by the internationally known Grasso Works of Hertogenbosch, Holland, are now sold and serviced through the Marquette Division, Curtiss-Wright Corporation. Here is the complete selection of economical hand tools that combine light weight and rugged construction with high speed and excellent balance for fast, comfortable, safe operation and long maintenance-free service. For production, maintenance, and general utility work the complete line of hammers, drills, sprayers, riveters, rammers, and the all-purpose 6-in-1 COMBINAIR kit meet every industrial requirement.

GRINDERS — Small, compact, and powerful with diameters from ¾" to 9".

HEAVY DUTY HAMMERS — Available with round and hex shanks and a wide range of fittings for cutting, scaling, chipping, caulking, etc.

COMBINAIR — 6-in-1 all-purpose tool. The basic unit, with attachments, can be used for drilling, cutting, sanding, buffing, corner drilling, and polishing.

FOR INFORMATION WRITE THE MARQUETTE DIVISION, CURTISS-WRIGHT CORPORATION.

CURTISS WRIGHT

MARQUETTE DIVISION

1145 Galewood Drive, Cleveland 10, Ohio

AD NO. 32-5

tion from society headquarters, 29 West 39th St., New York 18, N. Y.

Mar. 20-23—

Institute of Radio Engineers. International convention to be held at the Waldorf-Astoria Hotel and New York Coliseum, New York City. Exhibition and 54 technical sessions. Additional information available from institute headquarters, 1 East 79 St., New York 21, N. Y.

Mar. 20-24—

American Society for Metals. Western metal congress and exposition to be held at the Ambassador Hotel and Pan-Pacific Auditorium, Los Angeles. More information from society headquarters, Metals Park (Novelty), Ohio.

Mar. 27-29—

American Management Association Inc. Special manufacturing conference will discuss new concepts in planning, organizing to develop better processes and equipment, and trends in mechanization. To be held Drake Hotel, Chicago. Additional information from association headquarters, 1515 Broadway, New York 36, N. Y.

Mar. 27-31—

National Symposium on Temperature. Jointly sponsored by American Institute of Physics, Instrument Society of America, and National Bureau of Standards. To be held at the Veterans Memorial Building, Columbus, Ohio. Addi-

LAMINATING PRESS, introduced by Harco Industries Inc., automatically feeds itself, picking up a "sandwich" and placing it into the laminating compartment. Thermal adhering as well as polymerization adhesives can be used in manufacturing such products as printed circuit boards and self-adhering nameplates. The press can laminate in plastic any type of document up to 11 by 14 inches.

ERIEZ Magnetic Minute

60 seconds that will help you improve operating efficiency.

Let Eriez experience and know how be your MAGNETIC ENGINEERING DEPARTMENT

Eriez offers you a wide choice of magnetic engineering services at your plant . . . services which are the result of our research, field testing, and product development programs.

A wealth of magnetic know-how is available from our full staff of engineers and research and development personnel continually working on new ideas, new designs, new products, new applications.

Eriez devotes a major share of its engineering time to solving customers' problems in 3 major fields:

1. Use of Permanent Magnets to solve problems of separation of tramp iron or fine ferrous contamination.
2. Magnamation® — the principles of permanent magnetism applied to automation, particularly pertaining to ferrous parts, cans, etc.
3. Vibration — both electro-permanent vibratory feeding of all types of bulk materials and in bin vibration.

Whether you're an equipment manufacturer or a direct user, our wealth of technical help is available to you. Write to Chief Engineer:

ERIEZ MANUFACTURING CO.
119QA Magnet Drive, Erie, Pa.

MAGNA-THOUGHT

Engineering field service is one of our prime assets. Eriez men in the field are always ready with the information, help, and counsel you may need.

C. B. Giermak

CHESTER GIERMAK
Sales Manager

ERIEZ

A GROWTH COMPANY . . .
10 NEW PRODUCTS IN THE LAST 5 YEARS

Circle 672 on Page 35

DRYING metal parts after finishing processes, without leaving water residue stains, is the objective of a process called Trisec. A special drying solvent containing trichlorethylene, is used in equipment that resembles a liquid-liquid-vapor degreasing machine. Suitable for articles that are unaffected by trichlorethylene—such as glass, ceramics, and metals—the process and solvent are developments of Imperial Chemical Industries Ltd. Phillips Mfg. Co. Inc. is U. S. licensee for manufacture of the equipment, use of the process, and distribution.

tional information from V. W. Sikora, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Mar. 31—

Symposium on Packaging. Cosponsored by Packaging Institute and the National Paper Box Manufacturers Association. Symposium will highlight the use of set-up boxes in the packaging industry. To be held at the Sheraton Hotel, Philadelphia. More information available from Packaging Institute Inc., 342 Madison Ave., New York 17, N. Y.

Apr. 5-7—

American Society for Testing Materials. Symposium on materials and electron device processing to be held Benjamin Franklin Hotel, Philadelphia. Information available from society headquarters, 1916 Race St., Philadelphia 3, Pa.

Apr. 6-7—

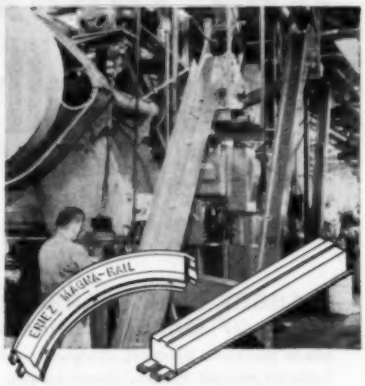
Management Engineering Conference. Cosponsored by American Society of Mechanical Engineers and Society for Advancement of Management. To be held Statler Hilton Hotel, New York. Details available from ASME, 29 W. 39th St., New York 18, N. Y.

Apr. 10-11—

American Society of Mechanical Engineers. Maintenance and plant

ERIEZ Magnetic Minute

60 seconds that will help you improve operating efficiency.



CONVEY, CONTROL, ELEVATE FERROUS PARTS faster...safer

Do it magnetically . . . with MAGNA-RAILS — from the Eriez line of Magnamation® (magnetic automation) components.

Powerful magnetic action holds items ranging from tiny tacks to large finished parts at fast speeds, up or down inclines as steep as 90°. You can convey on top **and** bottom sides of your lines; turn parts over automatically; change direction of flow, etc.

Use of steep inclines shortens belt spans, permits close grouping of machines to conserve valuable floor space. Positive hold prevents slippage of parts —reduces damage, cuts need for manual handling, increases safety.

Eriez field engineers will gladly show you exactly how MAGNA-RAILS help you move materials faster, safer, more economically, more efficiently . . . either on new or existing lines. Write to:

ERIEZ MANUFACTURING CO.
119QB Magnet Drive, Erie, Pa.

MAGNA-THOUGHT

By using exactly the right magnetic material for a given application, Eriez can provide each customer with precisely the right equipment to do a particular job.

W. J. Faller

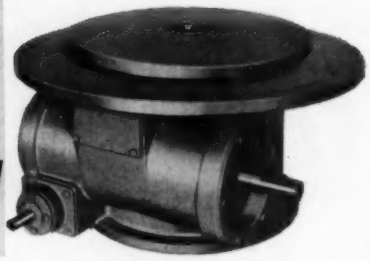
W. J. FALLER
Product Mgr. Automation

ERIEZ

A GROWTH COMPANY . . .
10 NEW PRODUCTS IN THE LAST 5 YEARS

Circle 673 on Page 35

Why Index Mechanically



Important Features of Mechanical Transfer–

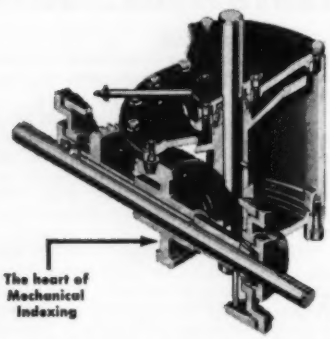
● SHOCK FREE TRANSFER OF MASSIVE LOADS

Made possible by cams designed and built to precise specifications to provide a high speed index or transfer motion with controlled acceleration and deceleration.

● SYNCHRONIZED TOOLING ACTUATION

Continued motion of the index cam shaft provides the power and basic motion for tooling actuation with positive mechanical interlock.

● ACCURACY OF INDEX



No other means provides such a high degree of precision repeatability of index. Regardless of number of positions accuracy is maintained. Transfer is never free—it is always contained by a tapered cam follower in the tapered cam path.

● INHERENT LOW MAINTENANCE

Standard Tool indexing equipment is practically maintenance-free due to its extreme precision manufacture and its carefully balanced components. Tapered roller bearings used throughout provide long durable service.

● TECHNICAL BOOKLETS

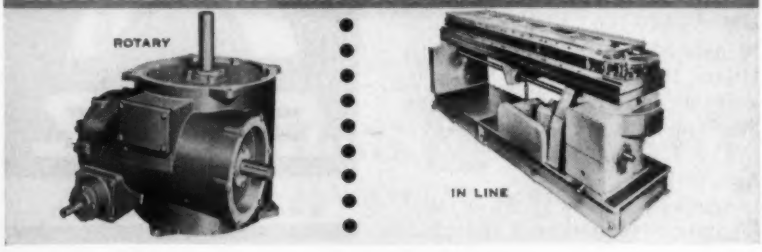
Fact-filled booklets showing indexing positions, tolerances, available dial and tooling plates, load ratings, dimensions and other information are available without cost. Standard Tool engineers will be pleased to assist you in selecting the indexing unit best suited to your particular requirements.

Better Products at Lower Costs thru Better Methods!

MACHINERY DIVISION

STANDARD TOOL & MANUFACTURING CO.
700 SCHUYLER AVENUE LYNDHURST, NEW JERSEY

SELECT FROM A FULL RANGE OF UNITS—IN LINE OR ROTARY



engineering conference to be held Bancroft Hotel, Worcester, Mass. More information available from society headquarters, 29 W. 39th St., New York 18, N. Y.

Apr. 10-13—

National Packaging Exposition. Sponsored by American Management Association. Conference and exposition to be held at Lakefront Exposition Hall, Chicago. Information available from association headquarters, 1515 Broadway, Times Square, New York 36, N. Y.

Apr. 17-19—

Fifth Conference on Manufacturing Automation. Cosponsored by Purdue University, Manufacturing Engineering Council, and AUTOMATION. To be held at Purdue University, Lafayette, Ind. For additional information contact: K. E. Glancy, Div. of Adult Education, Purdue University; or AUTOMATION, Penton Bldg., Cleveland 13, Ohio.

Apr. 17-19—

Instrument Society of America. Symposium on instrumental methods of analysis to be held Shamrock-Hilton Hotel, Houston. More details available from society headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

Apr. 17-21—

American Welding Society. Annual convention and welding exposition to be held at the Commodore Hotel and the New York Coliseum, New York City. Information available from society headquarters, 33 West 39th St., New York 18, N. Y.

"Yes sir, with this device you can count your chickens before they're hatched!"

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researches out the failures

You can't afford to experiment: the wrong kind of shipping container can cost you hours, customers and dollars.

So Gaylord packaging research engineers experiment for you with the complete box, liners, adhesives, interior design—the works. Every Gaylord container that you get is *proven*.

Does your product need a better container? Call your nearby Gaylord Man. Let him and Gaylord Research go to work for you now.

CROWN ZELLERBACH CORPORATION
GAYLORD CONTAINER DIVISION

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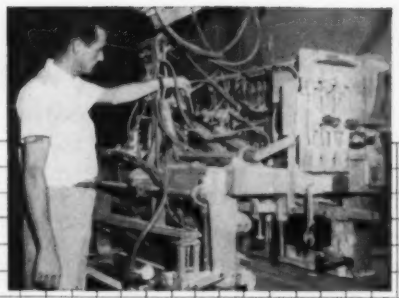
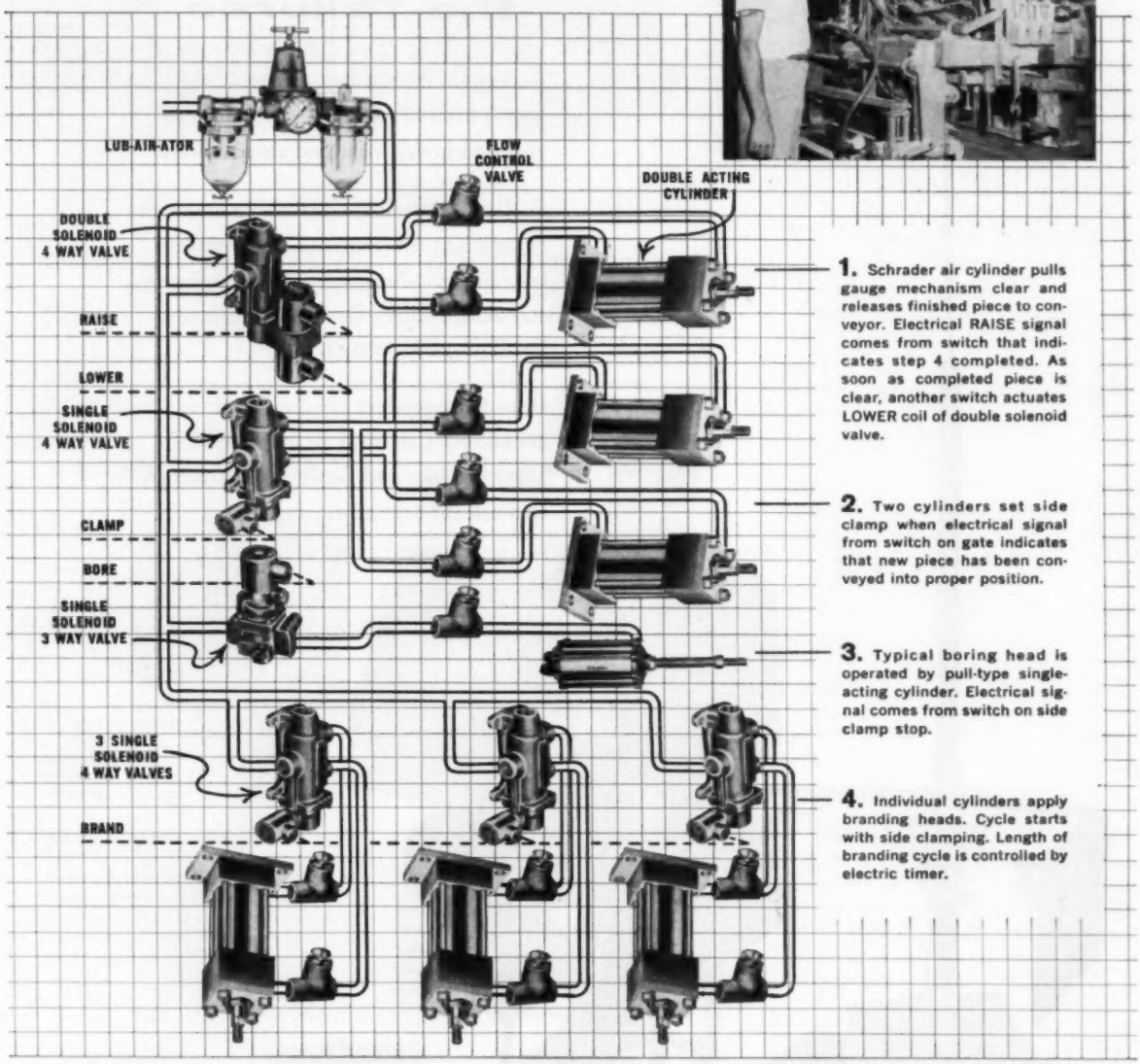
HEADQUARTERS, ST. LOUIS
PLANTS COAST TO COAST

Circle 675 on Page 35

The Lane Furniture Company of Altavista, Virginia, broke its cedar chest production line into groups of operations for air-automation. One of the many circuits, shown here, was designed with quality Schrader components to brand the chest tops with a trademark, bore hinge recesses, and perform vertical and horizontal gang drilling operations. All three jobs are completed in less than 30 seconds!





1. Schrader air cylinder pulls gauge mechanism clear and releases finished piece to conveyor. Electrical RAISE signal comes from switch that indicates step 4 completed. As soon as completed piece is clear, another switch actuates LOWER coil of double solenoid valve.

2. Two cylinders set side clamp when electrical signal from switch on gate indicates that new piece has been conveyed into proper position.

3. Typical boring head is operated by pull-type single-acting cylinder. Electrical signal comes from switch on side clamp stop.

4. Individual cylinders apply branding heads. Cycle starts with side clamping. Length of branding cycle is controlled by electric timer.

MANUFACTURER AUTOMATES PRODUCTION LINE WITH SCHRADER AIR CIRCUITRY... COMPLETES 3 JOBS IN 30 SECONDS

If your plant has production lines too long, unwieldy and costly to compete effectively, take a tip: Break your entire manufacturing sequence into logical *groups* of jobs. Then develop air-powered and air-controlled machines to perform each group in sequence. This company did, and now has versatile, fast, and economical production. *You already have air.* Expand its uses with versatile Schrader Air Products and discover true efficiency.

There is a fully stocked Schrader Distributor nearby . . . staffed with experts to help you solve any air circuitry problem. Consult the Yellow Pages or write:

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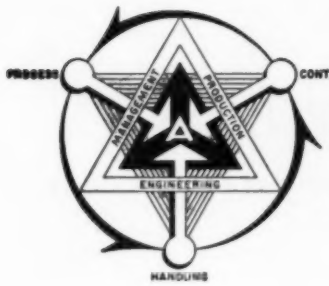
QUALITY AIR CONTROL PRODUCTS

Circle 676 on Page 35



around the triangle

DATA FIELD NOTES . . .

SELF-SERVE COMPUTER CENTER—A do-it-yourself computer center has been opened in Los Angeles by Computermat Inc. It operates along the same lines as a laundromat—the client solves his own engineering and scientific problems with a minimum of instruction. If assistance is needed, there is an experienced staff to help clients in the preparation of programs and in machine operation. An extensive library of programs and sub-routines is also available. An IBM 1620 system, which uses decimal arithmetic, was selected for use in the center.

SYSTEM CHECKS WINDING PROCESS—Production data system, made by Information Systems Inc., samples, records, and reports on winding machines at Owens-Corning Fiberglas Corp. The system continually scans 400 contacts on 200 winding machines every 11 seconds, simultaneously recording both the proper release of winding tubes and any irregularities in the winding process. Through continual scanning, sample comparison, storage and print out, the efficiency and quality of each machine can be determined instantly upon command or at the end of each eight hour operating period.

COMPUTER DESIGNED FOR SMALL FIRMS—Solid state digital computer has been designed for small to medium-size firms by Autonetics, Div., North American Aviation Inc. The machine, called Recomp III, has a 4096 word magnetic disc memory and can handle more than 8000 instructions. It has a list of 32 standard commands plus five optional floating point commands. Standard input and output is 10 characters per second by typewriter or paper tape punch. To extend the computer's potential, four input and output plugs are provided for optional equipment such as card readers, magnetic tape, line printers, and analog-to-digital converters.

SPEED-OF-LIGHT COMPUTER CIRCUITS—Basic circuits operating at speeds approaching that of light have been devised by the Radio Corp. of America, as the first big step toward an ultra swift electronic computer for the U. S. Navy. According to Donald H. Kunsman, Vice President and General Manager, Electronic Data Processing Div., the new circuitry can do its job 100 times faster than any system in existence and up to 1000 times faster than the circuits in most data processors now in use. In less than two seconds, the computer can do the same amount of work it takes an average system 30 minutes to perform. This advance in computer circuits is based on the use of tunnel diodes

MICROWAVE TRANSMITS METER READINGS—Gas meter readings are being sent 1200 miles by microwave to an electronic computer as part of a gas accounting system initiated by Natural Gas Pipeline Co. of America. The meter readings are sent from Houston and Amarillo, Tex. to the computer at the firm's home office in Chicago. The distance between Houston and Chicago is microwave-connected by 40 relay stations; Amarillo and Chicago are linked by 17 relay stations and a private telephone system. The volume of gas flow at each of 800 gas purchase points is measured and recorded on meter charts. The charts are calculated and punched into IBM cards, then fed into a printing data transceiver which sends the information by microwave to the Chicago office. The computer punches out a card every 4½ seconds containing the volume of gas and all data and factors used in its computation.

Information Service

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Fill in your name, title, address, etc.—Drop it in the mail—Your request will receive prompt attention and will be filled directly by the manufacturer.

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402	432	462	492	522	552	582	612	642	672	702	732	762	792	822	852
403	433	463	493	523	553	583	613	643	673	703	733	763	793	823	853
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429	459	489	519	549	579	609	639	669	699	729	759	789	819	849	879
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POST ELECTRONIC COUNTERS

ASSURE:

RELIABILITY • ACCURACY
LOW MAINTENANCE • PRODUCTION CONTROL

Post's *proven* electronic counters and control systems are in widespread use throughout industry. Serving such diverse needs as batch counting, measuring, sensing or machine control. Post electronic products are ideal production aids.

Note these examples of Post's broad line of Electronic Products . . .

COUNTERS

SD-1T Outmodes mechanical counters. Will operate at speeds up to 100 units per second. Single 'count' registers on visual totalizer as each 10th. item breaks beam. Note: 12 place tube available for counting dozens or gross lots.

P-5 Preset counting of any desired 'batch' — 1-100,000 units. Other models available for 10,000 or 1,000,000 range. Direct 'batch' readout on all models from totalizer . . . quantity less than 'batch' shown directly on tube face (s).

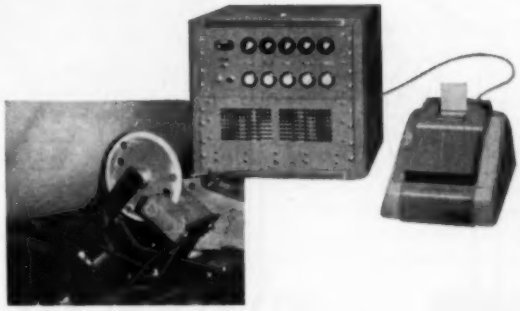
PW-5 PRESET Counter with BUILT-IN WARNING SYSTEM. Model shown will 'batch' count 1-100,000 units (inclusive) and warning selection dials may be set to energize a secondary control circuit, i.e., 'Batch' count desired 5000 . . . warning count desired 4900. When warning count reached, impulse may be given to flash light, operate solenoids for opening or closing feed gates, etc.

SENSING DEVICES

H-21-C A miniature, all purpose photohead. Ideal for limited space application. 'Head' not much longer than standard paper clip. Exciter lamp life 5000 hours. Utilizes photosensitive semi-conductor cell.

MH-2-P A new, compact magnetic switch in neat epoxy resin shell. . . . Magnetically operated as sensing device, the MH-2-P is capable of speeds up to 100 cycles per second — long life — no "bounce".

CONTROL SYSTEMS



LF-1A Lineal footage measurement, electronically . . . Capable of length measuring continuous production items, i.e., paper, wire, rope, ribbon, etc.
Features visual and printed readout.

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Circle 677 on Page 35

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P-5
PW-5
H-21-C
MH-2-P
LF-1A

Please send me product literature on the following:

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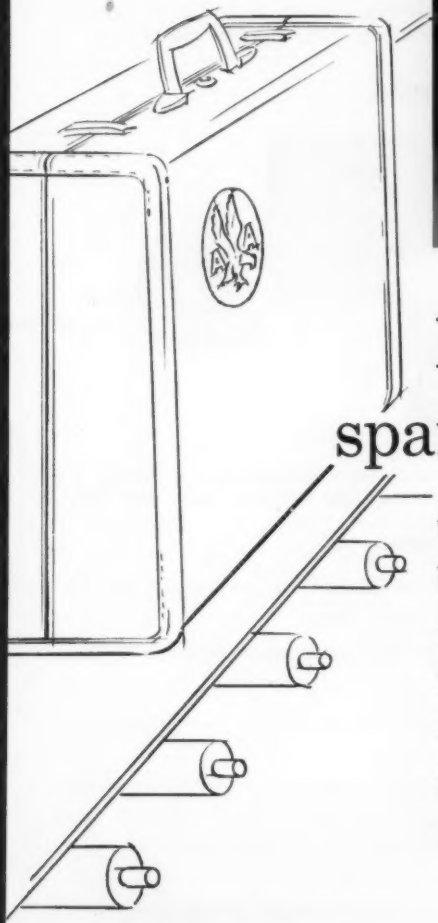
TITLE _____

COMPANY _____

ADDRESS _____

One Logan belt conveyor runs behind the American Airlines ticket desks, full length of the new terminal's 200-ft. main lobby. Ticket agents weigh and tag baggage and place it on this continuously-running line. Stainless steel kick plates give the conveyor an attractive built-in appearance and prevent accidents.

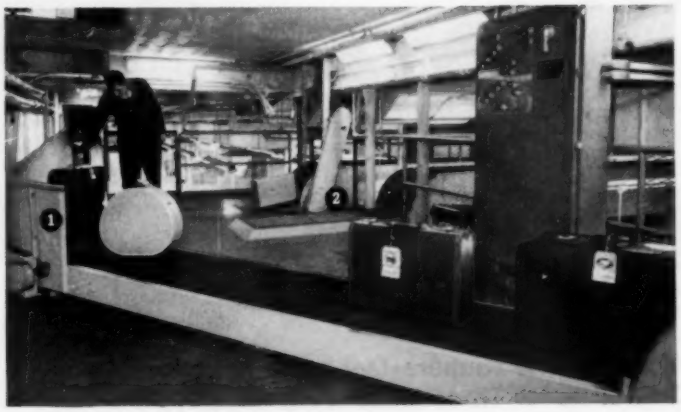


Logan *Plant Dynamation* sparks air baggage to jet pace

through the new American Airlines terminal at Idlewild

Like modern production machines, modern jet passenger planes call for new approaches to material handling. Photos on these pages show how a 700-ft. Logan *Plant Dynamation* conveyor system helps keep the baggage of 2800 daily passengers in pace with fast schedules. This feature of American Airlines' jet terminal at New York International Airport is part of the hemisphere-wide "Baggage Expediter System" for 707 Jet Flagships. The Logan conveyors have a peak capacity of 1500 parcels per hour—over 18 tons of baggage.

Much outbound baggage arrives by bus and limousine. These parcels are lowered by a combination chute and belt conveyor line, direct from the terminal's front ramp to the baggage sorting junction.



One level below the main lobby, all baggage enters a suspended junction platform area where it is sorted by flight and dispatched to proper loading areas. In the photo above the conveyor from the lobby is numbered 1, the line from front ramp numbered 2. The Logan control panel at right monitors and controls the entire conveyor system.

Why the leaders of so many industries call in "The Man From Logan"

Whether your problem is more like pacing suitcases through a terminal, appliances through assembly, or cookies through a bakery, the Logan field engineer takes hold like a specialist in *your* type of conveyors. There is a reason:

The Logan technique of Plant Dynamation cuts straight to the heart of any process and the individual needs of any plant. The Logan engineer helps you analyze your plant's *basic work-power patterns* . . . then moves step by step to design the one right conveyor system dictated by these patterns.

Over the half-century in which assembly-line production itself has grown up, Logan engineers have developed and proved the Plant Dynamation concept through thousands of custom installations, in a very wide range of fields. All this experience is focused on your job. On an average, "The Man From Logan" stationed near you has fourteen years of Logan training and experience.

One of the most comprehensive lines of conveyor equipment permits the Logan engineer to specify the one right system for you in every detail. Both as supplier and designer he commands five distinct modes of power and control. Every "Man From Logan" has made original contributions to modern automation.

"The Man From Logan" in your area is quickly available. He works with your engineers through design and installation to smooth operation. It is important to consult him early. Write or phone today for a conference on the *dynamation* of your plant.

One chute conveyor and two inclined belt conveyors lower bags to ground level points where final sorting takes place. Bags actually enter jet planes in the molded fiber "pods" seen on the right. The movable Logan conveyor in the background quickly returns to the junction platform any bags requiring re-routing. Total time from lobby to flight pod: about five minutes.

Logan Conveyors

LOGAN CO., 218 CABEL ST., LOUISVILLE 6, KY.

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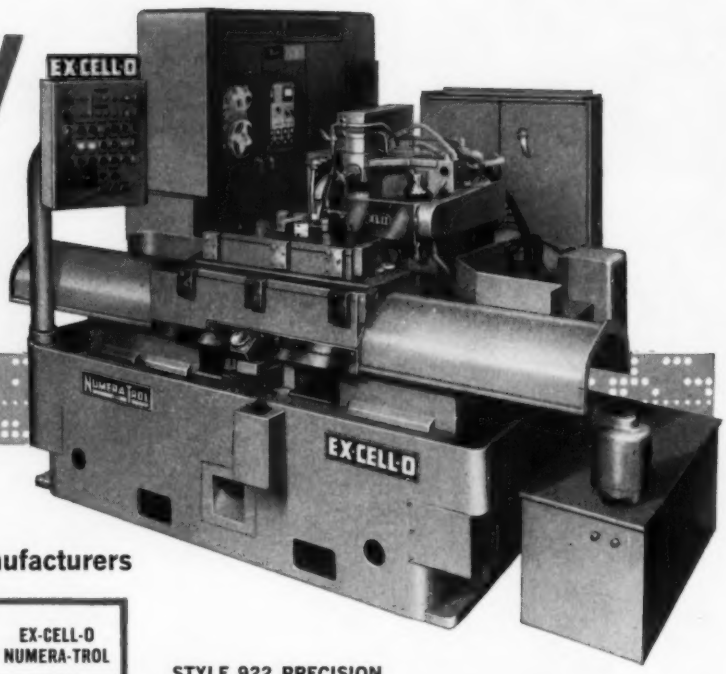
a study in time



How Ex-Cell-O Numera-Trol Cuts Costs for Three Modern Manufacturers

Part: TEMPLETS	CONVENTIONAL METHODS	EX-CELL-O NUMERA-TROL
Lead time	128 hrs.	16 hrs.
Grinding per/piece	60 hrs.	6 hrs.
TIME SAVED	166 HOURS	

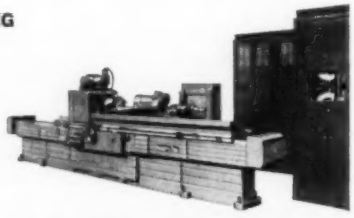
Part: FUEL CONTROL CAMS	CONVENTIONAL METHODS	EX-CELL-O NUMERA-TROL
Lead time	150 hrs.	40 hrs.
Machining per/piece	80 hrs.	7.5 hrs.
TIME SAVED	182.5 HOURS	

Part: STEAM TURBINE BUCKETS	CONVENTIONAL METHODS	EX-CELL-O NUMERA-TROL
Lead time	144 hrs.	24 hrs.
Machining per/piece	90 hrs.	12 hrs.
TIME SAVED	198 HOURS	

STYLE 922 PRECISION CONTOURING MACHINE
Slides are controllable to .000025". Grinding unit is interchangeable with boring and turning unit.

PRECISION CAM-MILLING MACHINE
Slashes lead time in producing drum-type cams.

PRECISION PROFILING MACHINE
Performs intricate and accurate milling and grinding of 3-dimensional forms.



Are you faced with tough prototypes or production parts that "can't" be produced economically? See your Ex-Cell-O Representative, or write direct for details on how you can apply Ex-Cell-O's Numera-Trol system of tape-controlled precision machine tools to do more jobs, faster and more accurately!

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NUMERA-TROL (XLO)

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Machinery Division
EX-CELL-O CORPORATION
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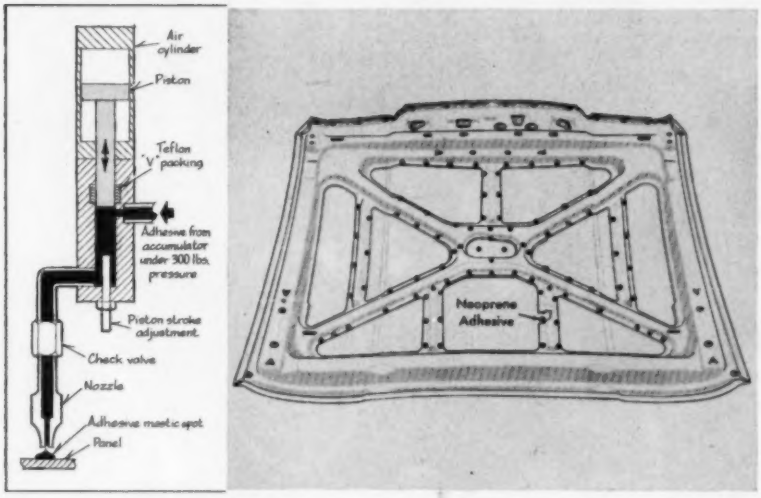
By JAMES C. KEEBLER, Editor



Sketch of hood panel shows location of mastic adhesive daubs between stampings. Bonding in this manner increases strength, reduces noise and weight. Sketch of air cylinder operated ejector shows design to dispense daubs of adhesive mastic. By installing another check valve and nozzle assembly on the other side of the ejector chamber the basic unit can be made to dispense two daubs simultaneously. Design and specification of Teflon "V" packing is critical to long life of unit. Leaks past this seal can shut down ejector.

Automatically Stuck

WINTER takes its toll on drivers in the snow areas. Some get stuck in the snow. Some slide on the ice and never make it home. Some slip through without mishap. Yet all suffer from winter's corrosive effects.

As spring moves in, many drivers look at rocker panels, fenders, and bodies to find they have been laced by the winter safety activities. The shape of these components is reminiscent of the formation of stalactites in the roof of a cave. The old jallopy seems to have been oozing off in drops onto the street below.

Bill Rice of the *Cleveland Press* editorialized on this problem and struck out at the use of salt on the city's streets. In fairness to all, he reported that suggestions concerning salt tending to make fenders rust off got a cool reception from the Salt Institute. He quotes their pamphlet:

"Iron placed in a pile of salt will not corrode. Iron wetted by water alone or a salt solution alone will corrode. The answer is that water is the corrosive medium."

Some critics have pointed the finger not only at the city fathers who use salt to melt the snow and ice but also at the automakers who build products that cannot withstand this treatment. There is reason to question whether any manufactured products should be subjected to such punishment, but the cold hard facts of life are apparent —they are.

Automakers Concerned

This problem is not without notice in autodom, and it is significant that the 1961 SAE International Congress and Exposition of Automotive Engineering included several papers on corrosion of automobile bodies. The engineering approach includes a study of all environments encompassing everything from the sooty industrial cities to the salty seashore and the sandy desert.

The responsibility is not only one of material selection and design, but also one of manufacture. Methods of seaming and joining provide conditions that either resist the onslaught of corrosive elements or foster their growing cancers.

In an interesting SAE paper entitled "Trends in the Manufacturing of Corrosion Proof Automobile Bodies," Herbert D. Van Sciver of the Budd Co. materials research laboratory states the case for an increased use of adhesives in auto body manufacture. One of the strong points of adhesives is that a lapped joint in shear loading can be structurally acceptable and not provide a crevice as in spotwelding. The adhesive itself fills the joint and keeps corrosive elements out.

One of the big reasons adhesives are not more widespread in auto applications is that manufacturing technology has not provided all the advantages enjoyed by other joining methods. For instance the clamping action of spotwelding heads oftimes makes up for minor mismating of stampings. Present adhesive bonding techniques do not accomplish this function to the same degree.

Present use of adhesives is not in the exposed areas, but product design configurations may be specifically altered with this problem and process in mind. Here is another example of the need for product designers and manufacturing engineers to progress together.

Daubs of Material

A look at one of the newer processing techniques in stamping plant operations of the Ford Motor Co. gives an idea of the ingenuity required to keep pace with the advancements in automobile manufacture. Hoods, deck lids, and doors must be fabricated in such a way as to minimize noise effects from fluttering of large panels. Ford's staff product engineers are specifying that such outer panels and their reinforcing inner mates shall be bonded together by daubs of adhesive mastic.

The material has a high rubber content and air-dries to a partial cure after the two parts are as-

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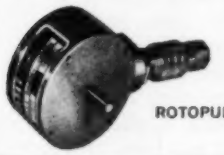
PROCESS CONTROLLER



ROTOPULSER

New product news from Louis Allis

NOW...Louis Allis offers DYNAPAR* Digital Control Systems!

Louis Allis can supply accurate digital controls designed to industrial standards for a wide variety of continuous process lines

For any production process, Louis Allis can furnish not only motors, drives, and controls, but also digital monitoring equipment to provide visual readout and process control signals.

The answer is DYNAPAR* Digital Control — a highly accurate digital logic system that can count, measure, totalize, indicate, time, or control depending on the requirements of the application. Digital systems are ideally suited for high speed counting — accurate measurement of speed and draw — automatic cutting-to-length — automatic positioning — and many other applications.

Dynapar's digital devices utilize precise pulses, and eliminate the drift inaccuracy inherent in magnitude-measuring analog systems. There's no need for constant calibration or adjustment. Pulses are reliably provided by rugged ROTO-PULSERS, highly stable sensing and pulse generating devices — visual indication is obtained by easily-read luminous direct numerical readouts. Control functions are accomplished by a variety of special devices tailored to specific operations. All DYNAPAR equipment features the most modern solid-state transistorized circuitry to provide long-life operation without maintenance.

Investigate to see how Louis Allis-Dynapar equipment can increase production and cut waste by automating *your* process. Call your local Louis Allis District Office, or write to The Louis Allis Co., 463 E. Stewart St., Milwaukee 1, Wis.

*Dynapar Corporation is the electronic subsidiary of The Louis Allis Co.

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

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LOUIS ALLIS

sembled. Completed panels are shipped from stamping plants to assembly plants where they are cleaned, phosphatized, primed, and painted. The adhesive achieves its final cure in the paint ovens.

Results of this technique of assembly are such that asphaltic paper pads are no longer required to accomplish the deadening of sound, and the spraying of mastic deadening compound (called dum dum in the trade) has been greatly reduced. The product designer has thereby achieved savings in both weight and space in addition to the cost of procuring and applying such materials.

On various lines at various plants Ford uses adhesive supplied by Du Pont, Prestite, and 3M's.

New Equipment

In developing production machinery to automatically apply multiple numbers of daubs to such panels prior to assembly, Ford's automation engineers found this to be a tricky material unlike anything they had experienced. The stickiness is reminiscent of the type of glue made famous by the Katzenjammer Kids cartoon. It sticks to anything right away.

Just as the mythical, mad scientist was hard pressed to find a container for his solution that would dissolve anything, so this adhesive that sticks to anything presents problems of how to move it and dispense it.

At Ford's Cleveland Stamping Plant it was found that the combination of stickiness and abrasive qualities meant short life for the standard lubricating type grease applicators first used to dispense this material.

The automation group developed special ejectors that are used in multiple arrays in their own design of mastic machine. They are successfully applying daubs on a production basis. The ejector consists of a double acting air cylinder with rod end threaded into an ejector body that forms a metering chamber for the adhesive. In the retracted position of the cylinder rod, adhesive flows into the chamber through a pressure port in its side. As the rod advances it closes off the sideport and forces the adhesive out through a fitting at the end of the chamber, through a ball check valve, and out a nozzle. When the cylinder retracts again a new charge of adhesive is admitted into the chamber. Stroke length of the rod may be adjusted by a setscrew in the end of the chamber.

Chamber size is such that one or two nozzles can be applied to each ejector chamber so that the ejector design can produce one or two daubs of material depending upon the pattern required. The mastic machine is essentially a cubicle with a vertically reciprocating table onto which a panel is placed by shuttle mechanism from the previous operation. Once the workpiece is in place, the table raises and positions the stamping to within one-quarter inch of the array of ejector nozzles suspended from the underside of the top of the cubicle. The ejectors all cycle simultaneously and deliver the daubs of material to the panel. The table is lowered away and the panel is pulled off by an unload shuttle mechanism.

Specifications require that each daub of material be shaped something like a Hershey Kiss.

The adhesive is pumped to the machine from an adjacent 55 gallon drum using a Lincoln Engineering drum pump that supplies an accumulator on the top of the machine. The accumulator is manifolded to each of the ejector assemblies and the ejector delivers through the check valve at a set rate. Because the solvents in the adhesive attack and swell rubber hoses, the only hose used for moving the adhesive in this equipment is an oversized main supply from drum to accumulator. All other lines are metal tubing.

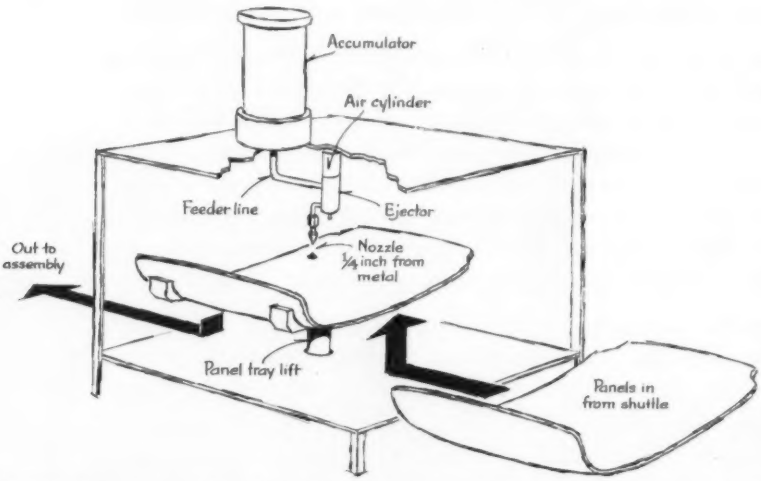
Inherently Flexible

Because of the building-block nature of the individual ejectors the equipment can be considered flexible and basic, for setup can be easily changed to accommodate panels of different sizes and shapes and is expected thereby to accommodate model change requirements.

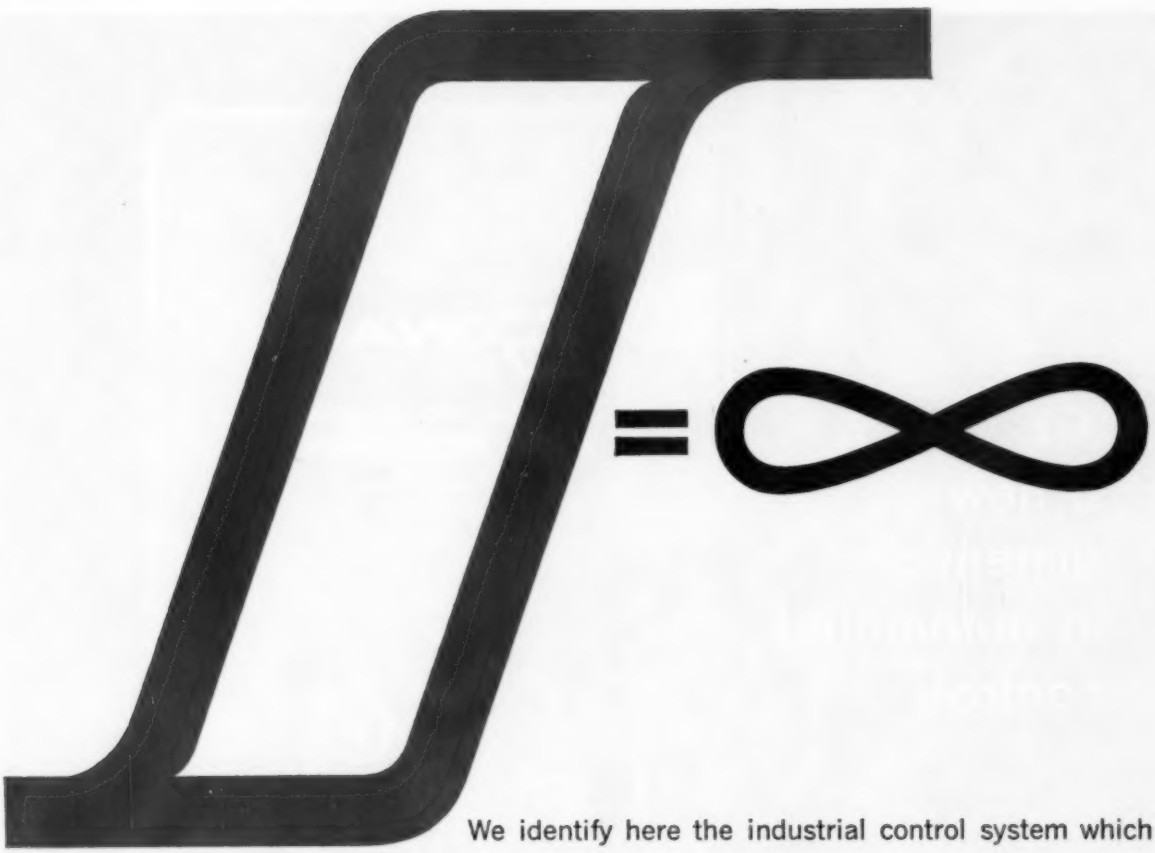
Presently the Cleveland Stamping Plant has these machines arranged in three specific configurations. One machine with 16 ejectors puts on 32 daubs of material. Another with 36 ejectors applies a like number of daubs, and another machine having two stations of 36 ejectors each, applies 104 spots.

The management acknowledges that it was stuck with a sticky problem and that the co-operation of Wyatt Sales Corp. and Airmatic Valve Inc. assisted considerably in the development of ejectors that would do this job.

As new product configurations are conceived, automaters must respond in this manner with equipment to do the jobs.



Sketch of mastic machine shows basic arrangement of panel and components of dispensing system for applying daubs of mastic adhesive. Accumulator on top of machine receives adhesive from drum pump that cycles only to maintain pressure in accumulator. An array of ejectors (some with single and some with double nozzles) are mounted under top plate of the machine in pattern required by mating stamping. All air cylinders are connected to manifolds that are serviced by a single air valve and thereby cycle simultaneously.



We identify here the industrial control system which will operate through an endless number of cycles without need for human direction, maintenance or servicing. The symbol for infinity in the equation shown above is obvious. The other symbol, the hysteresis loop ⎍ defines the system as *magnetic* static control. The word "static" is used because there are no moving parts. Thus, under normal operating conditions the system never wears out. Customers have come to us for magnetic static control systems which are in use today from the automated lines of New England textile mills to automobile assembly lines in Detroit, to the steel mills of the Argentine. If you, like they, wish to learn what operational statistics and costs *could* be by using magnetic static control for long life and dependability, will you please write us? Magnetics Inc., Dept. A-83, Butler, Pennsylvania.

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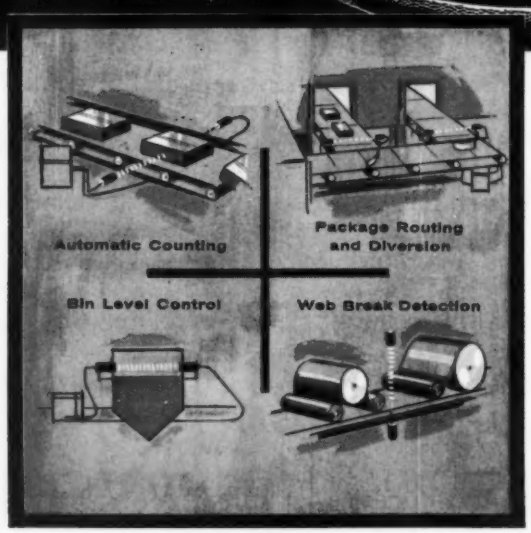

SONAC ULTRASONIC,

NON-CONTACT SENSING AND SWITCHING SYSTEM

Before Sonac, sensing and switching control systems which involved breaking a beam of energy were limited by vibration, dust, smoke, steam, air contamination and too much or too little light. Sonac's ultrasonic energy "beam" is completely free of these limitations. The acoustic lens on Sonac sensors can actually be painted without affecting performance. Utilizing high frequency sound also means there are no lamps to burn out. Savings in replacement parts and maintenance time often means Sonac pays for itself. Sonac is completely transistorized, providing you with a rugged, dependable electronic circuit.

These are just a few of Sonac's many uses. Optional equipment includes reflectors for precision beam and positioning control, and coupler assemblies for use with flexible tubing for remote sensor locations. This descriptive booklet will be sent to you on request.

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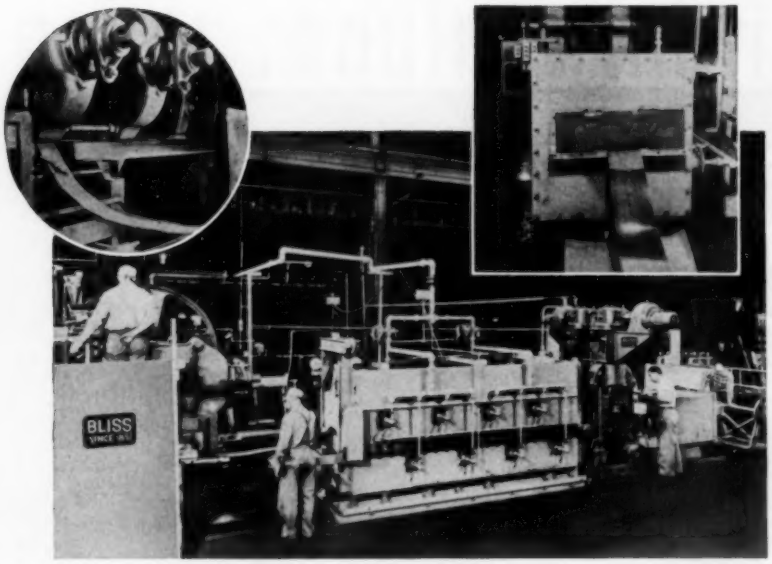


Copper powder, produced from ore concentrates by a chemical process, is converted to continuous copper strip by this equipment. Powder is fed into hopper at input end of line, left, and compacted to uniform thickness and density in special rolls, left inset. From the compacting rolls, the material moves through sintering furnace and hot mill rolls. Finished copper strip, of commercial quality, emerges continuously from system, right inset. Equipment of this type will be installed in new copper plant in The Philippines.

Copper Powder Processing

CHEMICAL conversion of low-grade ores into high purity copper—without conventional melting processes—will be accomplished in a proposed $23 million plant to be constructed in Iligan Bay, Mindanao Island, The Philippines. The copper, in powder form, will then be processed into strip, tubing, and wire by special techniques and equipment.

Announcement of the new type of copper producing plant was made jointly by Foster Wheeler Corp., prime contractor for the proposed project, and E. W. Bliss Co. which will furnish patented rolling and fabricating equipment for converting the powder into strip.

Also scheduled to participate in the project are Chemetals Corp., New York, and Sherritt Gordon Mines Ltd., Toronto. The latter firm owns and licenses the chemical reduction techniques.

Approval of a $13 million loan by the Export-Import Bank of Washington to Marinduque Iron Mines Agents Inc., a Philippine mining company, opens the way for construction of the new plant. The remainder of the cost will be made up by Marinduque in pesos.

According to J. Cabarrus, president of Marinduque, the capital cost of the installation to produce high purity copper by chemical methods will be 40 per cent less than that for a conventional smelting, refining, and casting plant of the same capacity. Marinduque will produce 14,000 tons per year of fabricated copper products from complex copper-zinc ores.

Useful byproducts will also result from the chemical process. For example, about 100,000 tons per year of ammonium sulfate, badly needed in the Philippines for use as a fertilizer, will be available. Also, approximately 5000 tons per year of zinc, either as an oxide or as electrolytic zinc for the galvanizing industry, will be produced.

Basic to success of the over-all process was the development of economical methods for converting the copper powder produced by the chemical process into useful forms such as high quality copper strip. This was the role of E. W. Bliss Co. which, in 1953, began a five-year research and development project to develop equipment and techniques for continuous rolling of strip from powder.

Problems that had to be solved before commercially practical rolling equipment was developed included:

- Extensive testing to find the best powder particle size and density.
- Development of special equipment to compact the powder uniformly.
- Establishment of the proper time, temperature, and protective atmosphere for sintering the powder.
- Extension of this atmosphere through the hot rolling and quenching cycles of the process.

As a phase of the project, the equipment illustrated was designed and built. Strip produced from powder in this equipment has been found to be equivalent to strip produced from ingots on conventional equipment, and has the required drawing and stamping characteristics. According to J. R. Patterson,

new–lube-free...

STERLING
Sealed and shielded bearings require no lubrication.
Keys are fabricated from tough elastic material to eliminate key and keyway wear.
Wear-resistant non-metallic bushings require no lubrication.
Shaft surfaces are corrosion-proof and require no lubrication.
CAUTION

...Sterling's variable speed drive never requires lubrication

Costs Reduced—One of management's biggest headaches has been the development and maintenance of proper lubrication schedules. As a consequence, lubrication problems have long been the cause of variable speed drive failures, pulley wear, sticky pulleys, shortened belt life, excessive noise, and many other equally costly problems.

High labor costs, coupled with increased maintenance needs, are major management problems.

Lubrication Eliminated—Now, Sterling has eliminated all lubrication maintenance problems. No part of a Sterling variable speed drive needs to be lubricated.

All bearings, sealed and shielded, are factory-lubricated and therefore require no lubrication. Shaft surfaces are impregnated with a special exceptionally tough and wear-resistant material which eliminates need for lubrication. The non-metallic bushings are also fabricated from a special material that is equally wear-resistant.

Special Load-Bearing Surfaces—At no time do these surfaces require any attention. Even the keys are fabricated from a tough elastic material and will not wear out.

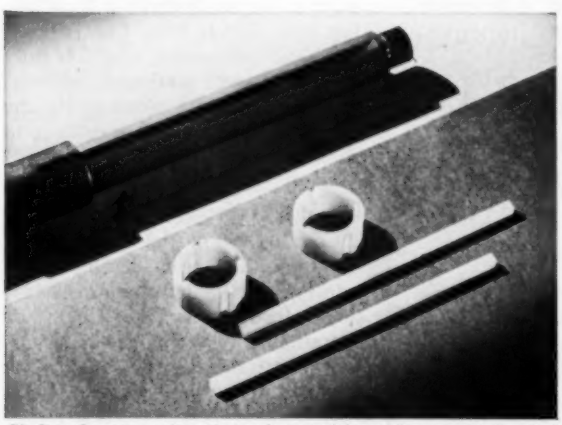
Fret corrosion, long a problem with metallic load-bearing surfaces, is completely eliminated since non-metallic surfaces now carry the load. Sticky pulleys, frequently the result of improper lubrication, are no longer a problem.

Sterling's new "Lube-Free" variable speed drive can be installed in any location, no matter how inaccessible, since lubrication maintenance is no longer needed.

Other Benefits—Costs are reduced, money saved, when lubrication maintenance is no longer necessary. Belt life is lengthened; pulley wear is eliminated. Bearing life may also be lengthened by the elimination of worn pulleys—often the cause of vibration and bearing wear.

All other Sterling variable speed advantages are present in this new "Lube-Free" drive: wide range of speeds, heavy duty cast iron case, finger-tip speed control, etc.

Information Available—Complete application and product information is available by writing Dept. B-4, Sterling Electric Motors, Inc., 5401 Telegraph Road, Los Angeles 22, California—or by contacting the Sterling field engineer in your area.



Shaft surfaces are extremely tough; material provides unusual chemical resistance and anti-frictional properties that make an excellent load-bearing material operating under extremely low or high temperatures. Keys and bushings are fabricated from a material proven to have outstanding abrasion resistance; holds up indefinitely under frictional conditions, thus eliminating need for lubrication.

This V & O Notching Press is powered by a new Sterling "Lube-Free" variable speed drive. It will never need lubrication. Similar units have been installed in the food processing industry. The elimination of lubrication is particularly important in the food processing industry where variable speed drives have such wide application, and where oil and grease create sanitation problems.

Hathaway INSTRUMENTS INC.

Sterling Electric Motors, Inc.

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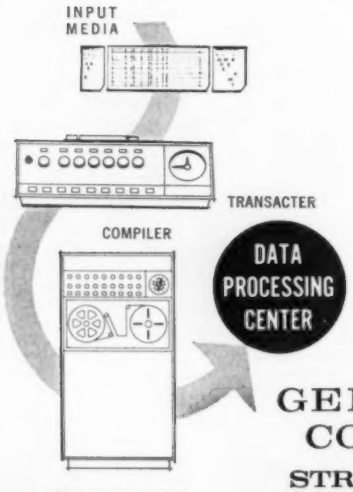
The TRANSACTER* System — the fastest proven method of accurate instantaneous data collection and transmission — provides management with complete data on production status and order location, inventory control, labor costing, tool crib and stores control, receipt and shipment, on-line communication. These are just a few of the many potential assignments for the TRANSACTER System.

Until Stromberg developed the new TRANSACTER System, no accurate, instantaneous method of source data collection existed. Industrial data collection and transmission was a relatively primitive operation — dependent on manual recording and delivery — subject to human fallibility every step of the way. Such methods were incompatible with the accuracy and efficiency of EDP and computer speeds.

The TRANSACTER System eliminates the paper work between widely scattered data sources and a central processing office. Management reports that have taken days — sometimes weeks — can now be produced in minutes! With the TRANSACTER System dramatic new opportunities for profit improvement become evident.

Write for informative booklet.



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Much of the powder used in the pilot rolling operations was supplied by Sherritt Gordon Mines Ltd. This material, produced by the chemical reduction process, was found highly suited for the continuous rolling equipment. Since that time, extensive investigations of Marinduque copper concentrates have been carried out to determine if they were amenable to the chemical process as it is commercially used. These tests proved that Philippine materials were suitable, and provided data for estimating plant capital and operating costs.

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Automatic mail segregating, grading, and facing equipment has been ordered by the Canadian Post Office from Elliott Bros. Ltd. of London. The equipment, which is fully automatic, will sort mail into orderly bundles with pieces facing the same way and graded according to size and class of mail.

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Counterpart of the rotary printing press has been developed for printing Braille by the Royal National Institute for the Blind. In operation, Braille characters are perforated on metal plates which are mounted on a rotary cylinder. Polyvinyl chloride paste is then forced through the perforations to deposit the characters on paper in the form of small, hard-wearing plastic beads. A pump, developed by Mono Pumps Ltd., removes the viscous paste from a drum and feeds it to the hopper of the press. A resilient stator and single rotating element in the pump provide self-priming action and eliminate the need for valves.

Circle 683 on Page 35

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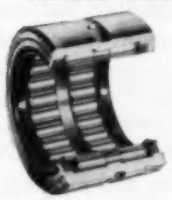

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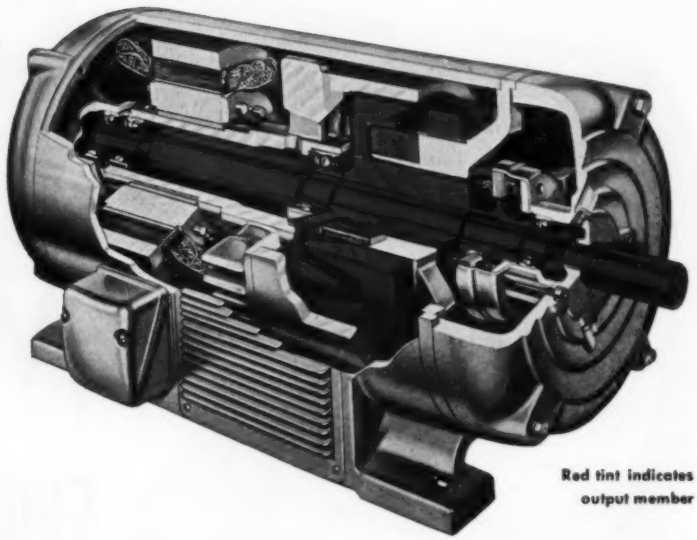

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The addition of the new model ACM-905 to the famous ACM-903 and ACM-904 lines of Dynamatic Ajusto-Spede Drives makes the desirable features of Dynamatic Quill-Type design available for many new applications.

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MARCH 1961

Accentuate the Positive

Humor has some peculiarities. One of these is a tendency to laugh at someone else's misfortune. The act of slipping on a banana peel and assuming an ungainly posture on a sidewalk is likely to induce laughter. Restaurant soup spilling is a form of comedy. Apparent failures of certain automated equipment installations have been popularly publicized in a manner that holds them up for ridicule by stressing the unsuccessful elements.

Emphasis of the negative or describing only the unsuccessful is done at the risk of overlooking any valuable elements related to a project and may tend to label as failures all parts of a development even though only a small portion may be faulty. The fact that an automated post office did not catch a phony postage stamp does not mean that automation is a fake. The engineer asks if the system design provided for manual or automatic validity checking, or any at all. The public concludes that automation has failed.

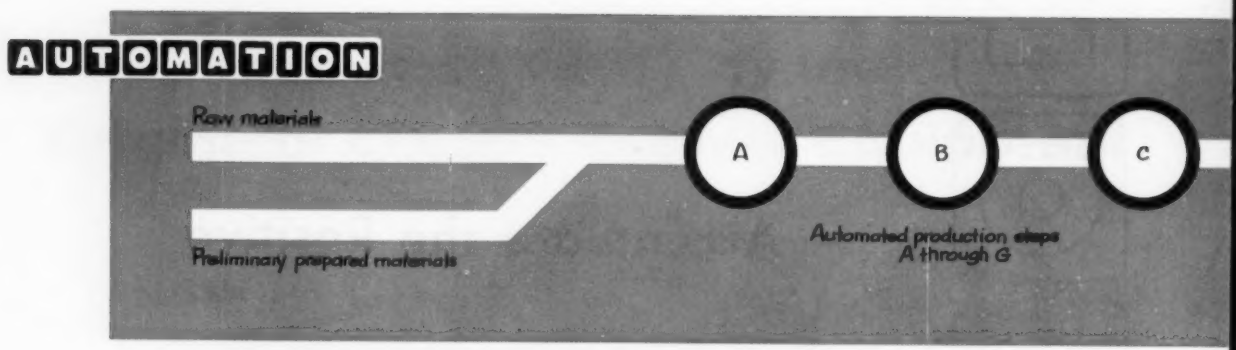
The fact that a company installed a computer and later discontinued its use may represent a misfortunate use of the company funds, but doesn't prove that computers are a waste of money. Other installations in other circumstances have been highly successful. The engineer who tried and failed might better be recognized as participating in progress and not harassed just for laughs. Learn from his experience—don't laugh at it.

Certainly the science of innovation has progressed rapidly in recent decades, but we are still a long way from the point where engineering developments are so surefire that any one particular project can be called proof that a given concept is faulty.

Some critics have called the positive approach used by most technical journals—Pollyanna. However, putting more emphasis on the good points of a development, while not ignoring the bad, merely recognizes the practical engineering goal of doing a job successfully. One might know thousands of ways to do a job wrong and still be unable to perform the task. He needs to know only one successful method to be able to accomplish it.

James C. Keebler

EDITOR



PLANNING AUTOMATED ASSEMBLY

In the analysis of assembly operations for the purpose of considering automated production steps, many influences deserve careful evaluation. The author discusses factors such as market outlook, standard-special product mix, verification of technical feasibility, quality, and handling costs.

By **H. C. DAVIS,** Chief, Manufacturing Engineering Div., Battelle Memorial Institute, Columbus, Ohio

COST-REDUCTION programs have brought about a high degree of automation in parts manufacturing of both large and medium-volume articles. The manufacture of appliance and automotive components is representative. But in many manufacturing operations, assembly has not been automated to such a high degree and, as a result, assembly costs are often high. Industrial products such as valves, regulators, and meters are typical of items whose assembly costs comprise a large portion of the total cost. In some instances, mechanized assembly has been tried with little success. In many of these cases, inadequate preliminary studies and planning have been responsible for the failure of the equipment to meet operational or economic specifications.

When should existing manual assembly procedures be mechanized? The answer is straightforward —not until a thorough technical analysis of the mechanization problem has been made and it is obvious that significant advantages can be realized. Such an analysis must include the study of cost factors, markets, operation specifications, and engineering feasibility.

The studies should take into consideration each step in the assembly process because many times savings are possible if certain operations are mechanized even though it would not be economical to mechanize the complete system. Experience has shown that in these studies various phases of the company's operations must be considered. Mechanized assembly may make changes necessary in scheduling detail parts and finished products, in material handling, or in product design. Therefore, a thorough study of the over-all system which is proposed, including detailed consideration of the various phases of the system, is required.

Consider Market Outlook

Because mechanized assembly equipment usually represents a large capital investment, it is obviously unwise to invest in it without adequate study of the market future. Efforts should be made to determine volume forecast for the foreseeable future and the product changes that are most likely to develop. For instance, the electronics industry cur-

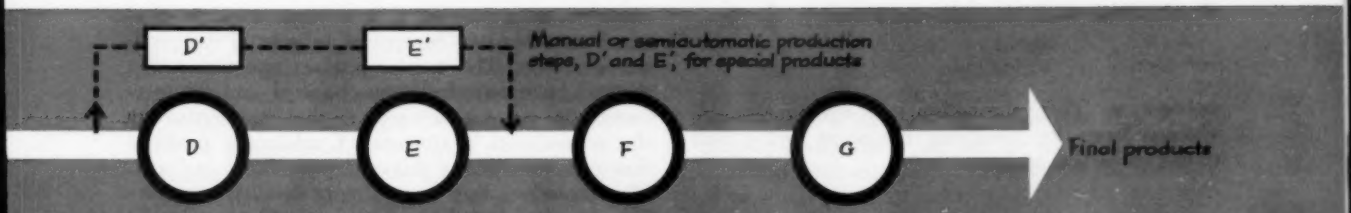


Fig. 1—Automated production lines can frequently produce special order items as well as regular models. Major product volume flow may go entirely through highly automated production steps while special items are bypassed to manual or semi-automatic steps for special operations.

rently appears hesitant to undertake broad assembly-mechanization programs because it is concerned about the future impact of miniaturization and micro-miniaturization developments on the components to be assembled.

If the market analysis forecasts reduction in volume, it may be well to drop the study at this point, or to limit its scope. On the other hand, if the market forecast indicates a promising increase in volume potential, this information should be used not only in establishing the scope of the study but also in planning equipment capacities and space facilities.

The cost of providing extra capacity later can be held to a minimum when possible expansion is taken into consideration in the original planning. Providing for a future expansion capacity of 20 per cent at the outset may require an additional expenditure of only 20 per cent of original facilities costs when the expansion is made. If the 20 per cent expansion is provided, without planning until after original facilities have been installed, the cost of the expansion may be 100 per cent of original facilities cost.

At this point it should be remembered that market forecasts are usually based on an average yearly volume, and that actual volume requirements may vary above this for certain periods. Consequently, either equipment capacity will have to be based on anticipated peak volume or the economics of storing complete assemblies will have to be studied.

The market analysis should indicate the time and duration of predicted peak market demands. A considerable length of time is often required to procure or develop mechanized assembly systems. Procurement and integration of commercially available equipment may require two to six months; development of specially engineered systems typically requires a period of one to four years, depending upon complexity of the system. Therefore, it is important that the feasibility of procuring required equipment be carefully evaluated with respect to predicted market fluctuations. To fulfill long-term, steady production requirements, a refined, highly automated system may be preferred; to fulfill short-term, peak-product-demand requirements, a relatively temporary system incorporating a reasonable number of manual operations may provide an optimum solution to the problem.

Market analyses can also be used in judging the need for changes in product design or operation. Also to be taken into account are seasonal effects on product demand or any subtle operating conditions that may affect production peak-load re-

TABLE 1—Steps In Evaluating and Planning Mechanized Assembly For a Product Line

- Become familiar with market aspects, both present and future, of the product for which mechanized assembly is being contemplated.
- Determine requirements for production flexibility in processing special orders.
- Formulate performance specifications for the mechanized-assembly process with respect to production rates, flexibility, and estimated future requirements.
- Acquire complete information concerning the assembly process steps, the cost of each step, and the difficulties commonly experienced with each step. Determine the most costly and troublesome operations.
- Make preliminary engineering plans to mechanize the costly operations, grouping those operations in an integrated mechanical system if possible. Make preliminary estimates of technical feasibility, and prepare estimates of the equipment and operating costs.
- Compare costs of the mechanized-assembly proposal with the costs by present methods. Arrive at a decision on the mechanization proposal.
- If the decision favors mechanization, perform experimental investigations on those individual operations of most questionable feasibility. Modify product design if necessary.
- Upon experimental proof of technical feasibility of the questionable operations, proceed with standard equipment procurement, special equipment development, and planning for the integration of the mechanized system into the over-all manufacturing process.

quirements. This information may also provide additional bases for specifying the scope and details of the evaluation study.

Analyze Scheduling Requirements

Because mechanized assembly usually requires more time for planning and permits less flexibility for special orders, a study should be made of the assembly schedules to determine the amount of lead time they provide for planning production on regular models and the time allowed for special orders. The typical distribution between regular model and special order production is important. Normally, it is necessary to provide a rough estimate of the potential savings that the less flexible mechanized system will offer. Estimates can also be made to point out the predicted cost of maintaining flexible scheduling. At this point, a management decision may be required as to the course to follow. The mechanized assembly equipment which is developed must be compatible with sales potential and operating policies of the company.

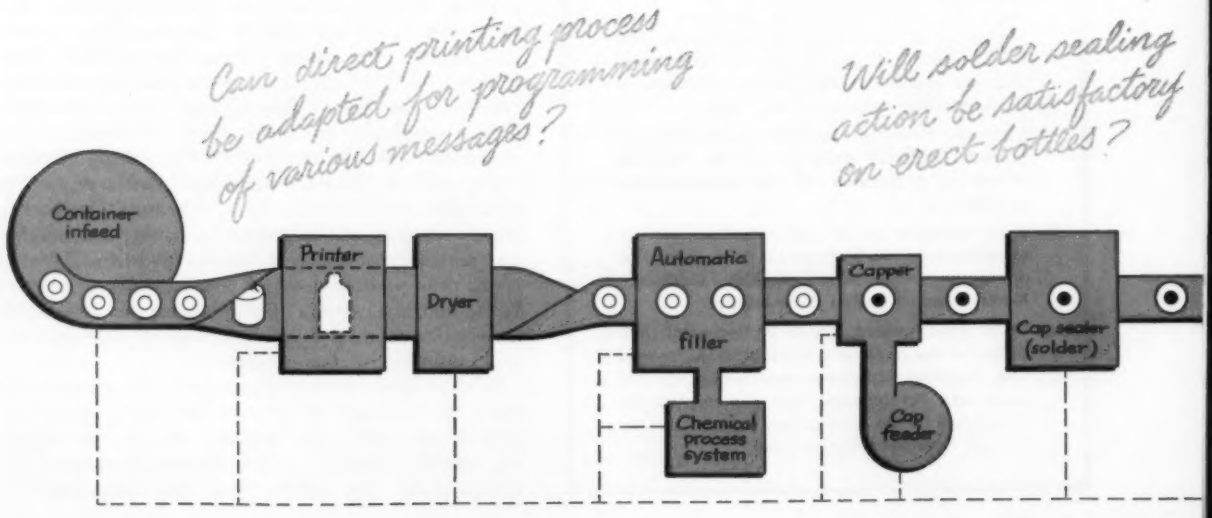
Many times a company may refrain from entering into the study of mechanized assembly equipment because a portion of its production volume involves special orders which do not lend themselves to assembly on mechanized equipment. For example, paint brushes are typically provided with specific bristle formulations, or mixtures of bristles for best results under different conditions. Brush formulations are specially tailored or adjusted to meet certain consumer or customer needs. However, the variable aspects of this one operation need not influence the standard production operations, such as handle attachment, cementing, and packaging.

Special-order assemblies, in many instances, are basically the same as standard assemblies with the exception of a few parts or subassemblies. Mechanized assembly can be applied to most of the product demands. The special product operations that cannot be economically mechanized can be performed in an area adjacent to the area containing the mechanized equipment. A schematic product-flow representation of this concept is shown in *Fig.* 1. This procedure may require more detailed engineering planning, but the cost savings will often justify the expense of the additional planning.

Assess Technical Feasibility

If market analysis and production control studies are favorable, it is the responsibility of manufacturing engineers to determine the technical feasibility and the economic implications of mechanized assembly. Many times the use of highly mechanized assembly equipment may appear technically feasible with the exception of one or two operations. In such cases it is advisable to conduct experimental work on the questionable operations before continuing with over-all mechanization planning, because mechanized equipment systems are similar to a chain which is only as strong as its weakest link. Thus, it would be extremely costly to have a machine system designed and constructed in the hope that known problems can be overcome, only to find that these problems cannot be economically solved.

A proved analytical approach is commonly employed by manufacturing research engineers when they conduct preliminary engineering studies of mechanized equipment. First they determine the optimum assembly system for the manufacturer's specific situation, and then they establish the feasibility of any questionable engineering aspects of the system. This method is utilized to insure, from the outset, sound technical bases for the system development and to forestall major construction and development commitments until the feasibility of questionable technical aspects of the proposed system has been established.



To provide an example of this engineering pre-analysis in defining the immediate experimental needs of the development, *Fig.* 2 shows a hypothetical assembly system proposed for feeding, liquid-filling, capping, and sealing glass containers. The system calls for programmed variations of direct-printed information on the containers, metal capping, and solder sealing of the caps to the glass containers.

Let us assume that all of the techniques required for the success of the system have been technologically established except for the programmed variable direct printing, and the solder sealing of the metal cap to the glass container in the required erect position. In this case, the techniques and specific mechanical details of the printing and cap-sealing operations can, and should, be developed in the laboratory before development of the entire system is undertaken. The feasibility of these most questionable process features may be established in a relatively inexpensive program by utilizing temporary, experimental equipment, if the work is performed by technologists experienced in pertinent fields. Positive results justify proceeding with the over-all system development.

Quality and Handling

Some assemblies are made up of such a large number of detailed parts and subassemblies that it may be impractical to mechanize their assembly extensively unless the production volume is extremely high. In such cases it is a matter of analyzing all assembly operations to determine the specific areas in which potential reductions in cost will justify the cost of the mechanized equipment.

Mechanized assembly operations offer two big potential advantages: First, they can be used to improve product quality and uniformity. Second, they can be used to eliminate or reduce manual handling of detail parts and subassemblies. In both areas, the complete range of mechanization possibilities should be considered, from the application of simple, auxiliary devices to the application of specifically designed, special-purpose machines.

In many instances mechanized equipment can provide a better quality product and reduce the inspection or adjustment requirements. This should also be considered a savings in estimating the cost of mechanized equipment. The automatic assembly of products such as locks, relays, books, and electrical connectors has made possible a product uniformity and quality uninfluenced by human factors of workmanship or fatigue.

In many assembly operations the cost of transporting detail parts, subassemblies, and assemblies in process is a substantial, but overlooked, part of the assembly cost. The tote-box used to collect parts in process may also be a collector of transportation costs contributed by skilled assembly technicians, a portion of whose time is spent in materials handling, collection, and movement to other process stations. Often it is difficult to determine the actual current material-handling cost, because it represents the time of material-handling personnel as well as the time of production operators as they transport parts, subassemblies, and assemblies in process. It is usually costly to have production operators engaged in these material-handling operations. Thus, to reduce material-handling costs, mechanization should reduce production-operator handling to a minimum.

Further Considerations

In planning new equipment for mechanized assembly, it may be found that some operations cannot be performed because of certain design details of a part or a number of parts. Further analysis may show that a redesign of the part might overcome this problem without affecting the quality of the product. Therefore, it is desirable to combine the talents of manufacturing engineers with those of product-development engineers so that these problems can be resolved promptly and effectively. This procedure is important when there are plans for automatic feeding or registering of parts, since process holes or modification in detail dimensions are often required for orienting and feeding parts properly.

Especially if the required equipment is complicated, careful consideration should be given to operating and maintenance costs such as the cost of utilities, repair, and setup. If the new equipment will permit the same operations to be performed in a smaller area, this may be considered a savings if the area can be utilized for other work.

The initial decision as to the justification for assembly mechanization will of necessity be based on a rough estimate of the proposed equipment and operating costs. If only a marginal economic advantage from mechanization seems likely, it might be necessary to perform additional detailed analyses to predict equipment and operational costs more closely. With this additional information, final decisions based on reasonably accurate data will be possible.

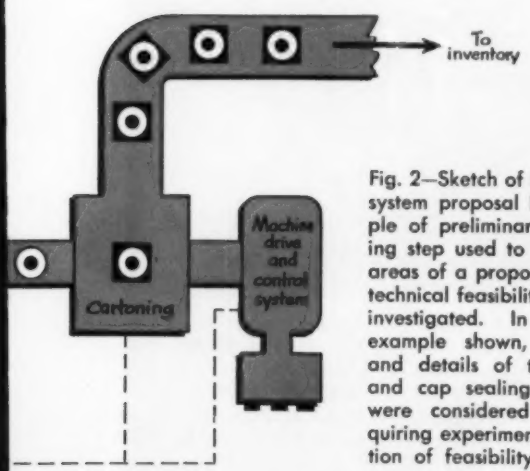
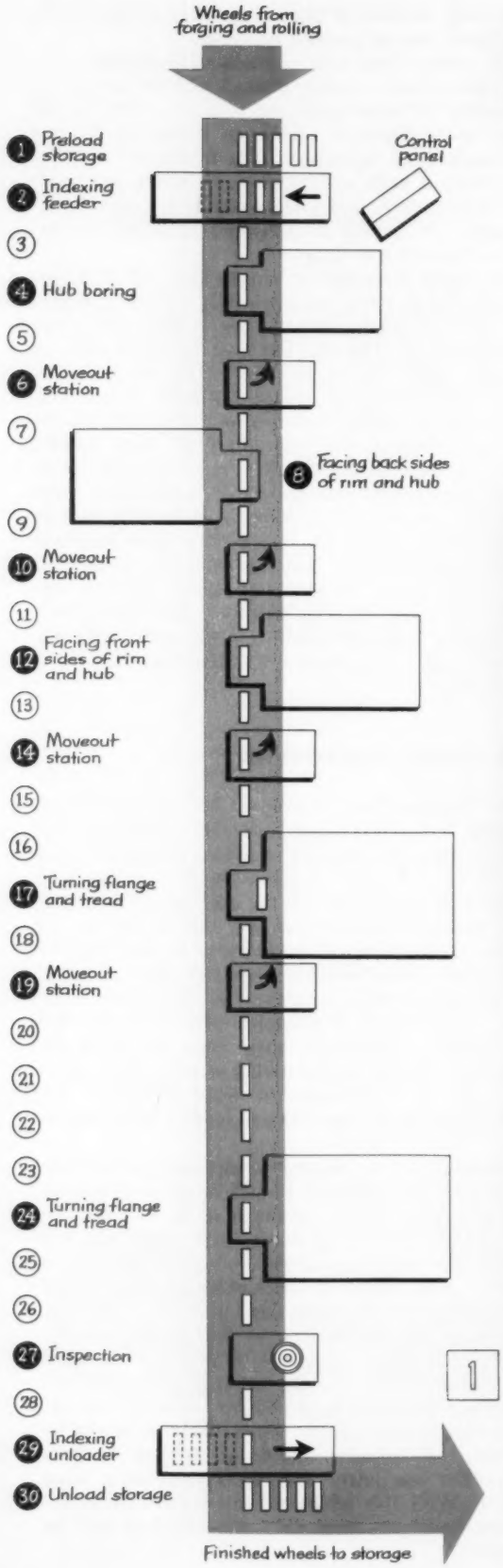
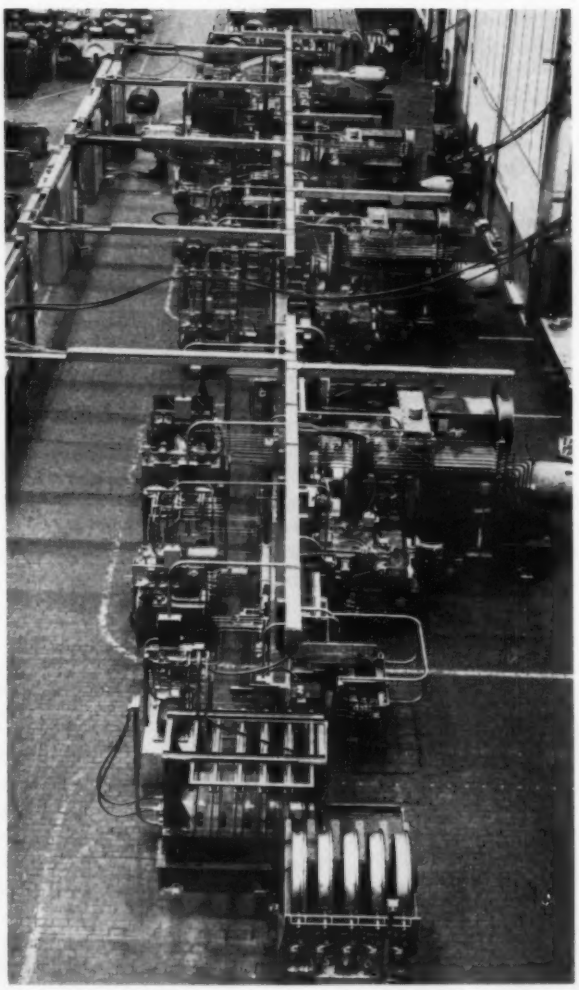


Fig. 2—Sketch of hypothetical system proposal is an example of preliminary engineering step used to help define areas of a proposal in which technical feasibility should be investigated. In the line example shown, techniques and details of the printing and cap sealing operations were considered areas requiring experimental verification of feasibility.

AUTOMATION TODAY

MACHINING RAILROAD





Over-all view of the transfer line for machining railroad car wheels is shown in the photograph. Forged wheels are loaded into the system at the far end of the line, and finished wheels are removed at the near end. The diagram illustrates the operations performed at each of the thirty stations in the line. Output of the automated line is approximately 48 wheels per hour.

2

At the beginning of the line, wheels that have been forged and rolled in another part of the mill are lifted into the preload storage rack in groups of five. When the indexing feeder at Station 2 is empty, it is aligned with the preload storage rack, and horizontal roller shown pushes the wheels into the feeder.

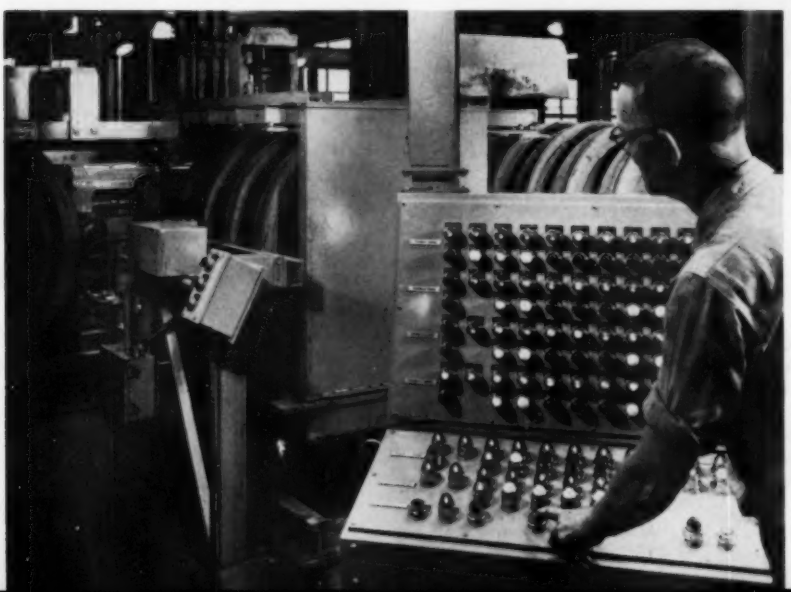
WHEELS

AUTOMATED transfer line for machining railroad car wheels has been installed at the Standard Steel Works Div., Baldwin-Lima-Hamilton Corp., to produce wheels of consistently uniform dimensions. The line introduces a new concept in handling this type of product in that the wheels are automatically rolled between stations and are machined in a vertical position. Past practice has been to machine car wheels in a horizontal position on individual machine tools.

The 30-station transfer line consists of five major machine tools which are interlocked with load, unload, and inspection stations. Designed by Kearney & Trecker Corp., the line consists of a preload storage station, an indexing feeder loading station, a hub boring station, two machines for facing the front and back sides of the rim and hub, four move-out stations for inserting or removing wheels from various parts of the line, an inspection station, an indexing unloader station, an unload storage station, and 16 idle stations intermingled between the various components.

The system is controlled from a master panel which is designed to allow the entire line to be operated as a single machine or to enable each machine and its intermediate units to be operated individually without affecting the rest of the line. Individual control panels at each machining station can be used to operate the station during tool setup, maintenance, or independent station operation.

The machine is unique in that all transferring and machining operations are accomplished with the wheels in a vertical position. The wheels are rolled along an actual section of rail and are pushed by hydraulically actuated rollers. These rollers move the wheel from station to station and maintain a constant spacing of the wheels on the line. The line is approximately 118 feet long, 30 feet wide, and 7 feet high. Output of the line is approximately 48 wheels per hour using four men. These include a



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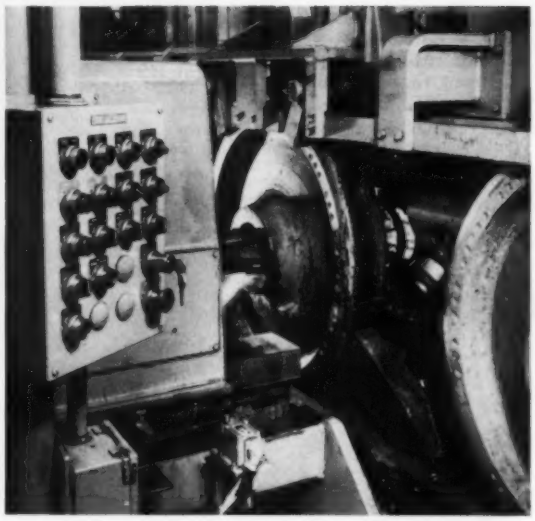
The indexing feeder at Station 2, center background, rides on rails mounted transverse to the transfer line. As the unit is indexed across the entrance to the line, the feeder stops and a roller on a transfer bar pulls a wheel into the line on the left. In the foreground is the control panel for the system. Lights on the panel are keyed to each machining and handling operation along the transfer line. All operations can be controlled manually or automatically from the panel.

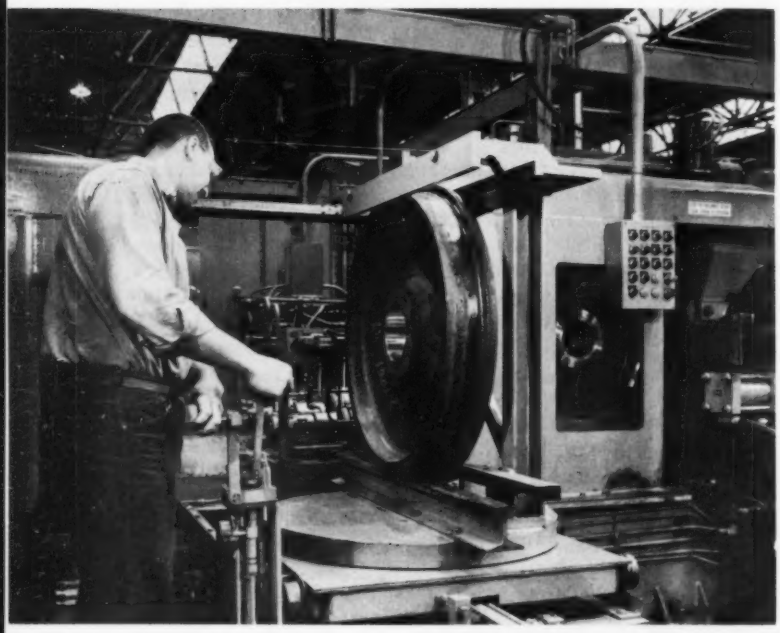
machine operator and his helper, an inspector who performs a 100 per cent wheel check at Station 27, and a lift truck operator who loads wheels at Station 1 and removes finished wheels at Station 30.

The accompanying illustrations point out the various features of the transfer line.

4



At Station 4 the wheel hub is bored. Bore settings can be varied from 4¾ to 8 inches, depending on the type of wheels being processed. Two roughing and two finishing tools on a boring bar are used to make the bore cut. While the wheel is being bored, it is securely held in place by retractable chock blocks, one of which is shown on the lower right of the wheel. Immediately above the chock block is one of the transfer roller assemblies in a withdrawn position. Each assembly consists of two rollers mounted on a frame which is attached to a hydraulically actuated transfer bar. During the transfer of wheels between stations, the roller assemblies are between the wheels. After transfer, the transfer bar rotates, withdrawing the rollers, retracts to the right, and then swings the rollers between the following wheels.



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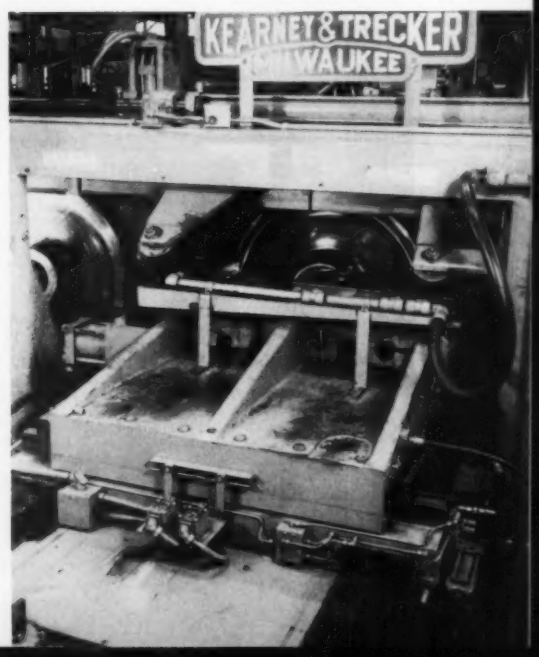
Located at Stations 6, 10, 14, and 19 are moveout positions similar to the one shown. These stations provide a means of inspecting the wheels in process and to insert or remove wheels from the line. Normally, the moveout stations are kept closed. When opened by an operator, a carriage moves a wheel from the line and rotates the wheel 90 degrees. Notice the section of railroad rail upon which the wheel rolls in the transfer line which runs from right to left in the background.



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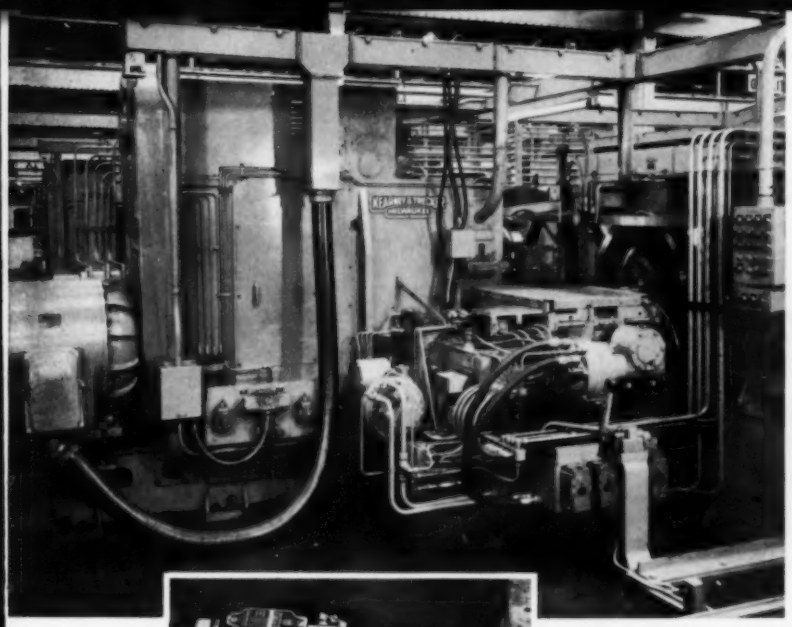
This view shows the facing operation at Station 8 where the back sides of the rim and hub are machined. Four carbide cutting tools accomplish this operation, two face the rim and two face the hub. The tools are employed in such a manner that one tool cuts from the outside in while the second tool simultaneously cuts from the inside out. A similar machine is in operation at Station 12 where the front sides of the rim and hub are faced.



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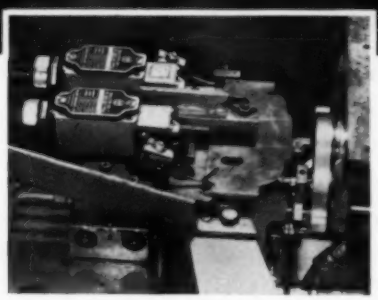
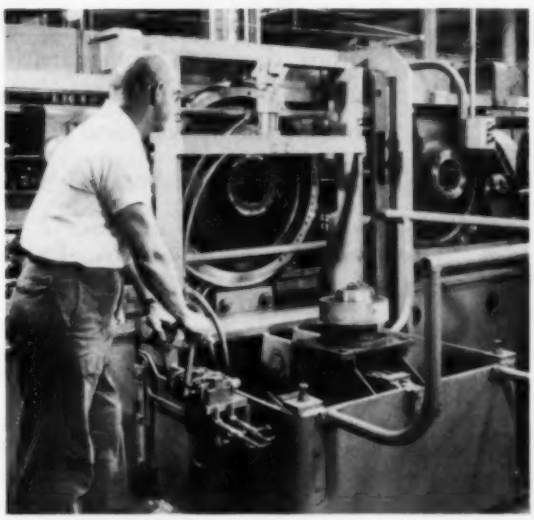
There are two turning machines in the line at Stations 17 and 24 since turning takes twice as long as boring and facing. Starting at Station 15, the wheels are transferred between two stations at a time. One wheel is carried past the first turning machine while the next wheel in line is machined in the first turning machine. The bypassed wheel is then machined in the second turning machine. On each turning machine, the flange cutting tools are guided by a hydraulic tracing attachment, inset, on which a stylus follows a pattern of a template and determines the path of cutting tools in machining the flange. A carriage on the lower side of the machine turns the tread.





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All wheels are visually inspected at Station 27. The inspector first examines the back of the wheel by causing rollers in the line to revolve the wheel. He then causes the frame to swing downward and drop the wheel on the vertical spindle in the foreground. This permits him to examine the front of the wheel and check critical measurements with hand tools.

9

At Station 29, finished wheels collect in an indexing loader similar to the feeder at the beginning of the line. When five wheels have been fed into the unloader, the unit is automatically positioned to unload the wheels into the storage stand at Station 30. This cannot occur until the lift truck operator has removed the previous load of wheels from the stand and has pressed the pushbutton in the foreground. If the operator fails to do this, the entire transfer line stops. As soon as the pushbutton is pressed, the unloader transfers the collected wheels to the storage stand.

UNIQUE READ-WRITE TECHNIQUE UNDERLIES

MAGNETIC TAPE CONTROL OF TURRET LATHE

Principles of magnetic tape recording and playback permit a variety of approaches in establishing a control system. Here the author discusses considerations leading to the use of a unique numerical control system in a turret lathe, supported by descriptions of the system and the steps in programming a tape.

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A NATURAL tendency of American industries to organize their way out of seemingly unnecessary general problems has led to interest in standard forms of numerical control. Limited success has been obtained to date because the entire field of numerical control is still young enough to make any firm analysis of its future direction of growth a matter of conjecture. However, whatever the future, this much seems certain: "Standard" solutions hinge upon the existence of "standard" problems and, for practical reasons, where uniqueness of problems exists, then uniqueness of solutions will be found.

This aspect is illustrated in the application of numerical controls to automatic turret lathes. In

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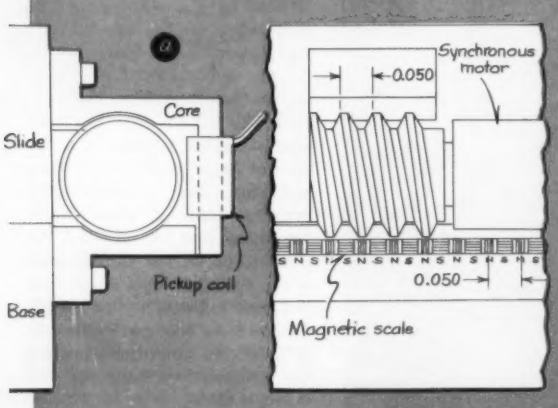
PRINCIPLES OF OPERATION



UNIQUE feature of Factrol magnetic tape control system is the use of rotating magnetic scanning heads in the command input circuit and position feedback circuits. For a given axis to be controlled, the general scheme of operation is based upon a comparison of characteristics of command and position voltage signals generated in pickup coils by rotating the scanning heads in the presence of controlled magnetic fields.

In a position indicating or feedback unit, the magnetic field is in the form of a scale, normally fixed to the base of the machine tool, *Fig. A.* The magnetic scale is made of a material which can be permanently magnetized in a particular manner. For example, as applied to a cross slide, the scale is magnetized to have alternate north (N) and south (S) poles along its entire length and spaced 0.050 inch apart. An accurately machined 0.050 pitch screw made of magnetically conductive material is rotated in close proximity to the magnetic scale. A pickup coil is wound on a core member that forms a closed magnetically conductive flux path between the scale and the rotating screw. Each time the screw makes a revolution, the tops of the threads which are close to the scale advance from an N-pole to an S-pole and back to an N-pole. The magnetic flux passing through the pickup coil starts out as a strong

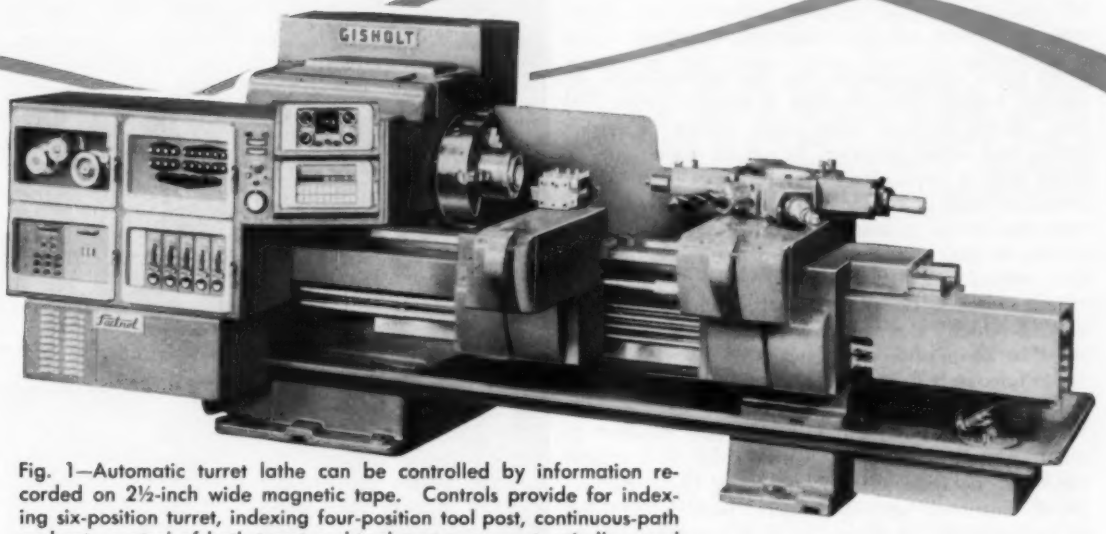


Fig. 1—Automatic turret lathe can be controlled by information recorded on 2½-inch wide magnetic tape. Controls provide for indexing six-position turret, indexing four-position tool post, continuous-path and rate control of both turret and tool post movement, spindle speed selection, and coolant flow control.

several instances, major manufacturers of such forms of machine tools have developed unique types of control because of limitations found in available control designs. The problem of adapting existing control designs to turret lathes primarily has involved practical considerations rather than feasibility considerations. For example, practical considerations dictate that numerically controlled turret lathes must compete with turret lathes equipped with other forms of well developed and somewhat sophisticated automatic cycling and tracer controls. This leads to the question of "How does tape control fit into the picture of controlling automatic turret lathes?"

▶ Conventional Control

The modern automatic turret lathe consists primarily of a spindle with means for driving it at one of several predetermined speeds, and a turret with means for power indexing and arranged to move at a rapid rate for approach and retract, and at one of a number of prearranged feed rates. One or more cross slides are available to operate either with the turret or independently.

The correlation of turret face with spindle speed, feed rate, position at which rapid advance changes to feed rate, position at which feed motion stops, choice of retract cycle, and other functions which

N-S flux, becomes weaker as the screw threads approach a position half-way between N-S poles, and becomes zero at the half-way point. The flux then reverses direction, becoming very strong in the S-N direction as the tops of the threads are over the S-poles, weakening to zero at the half-way point between S-N poles, and finally reaching full strength in the original direction as the revolution is complete. The result of this cycle of flux variation is to generate an ac voltage in the pickup coil which goes through a complete cycle for each revolution of the screw. The pickup coil, scanning head, and scanning head motor unit are attached to the slide. The motor unit is a synchronous motor driven from a 120-cycle ac power supply at 7200 rpm so that a 120-cycle ac voltage is generated in the pickup coil.

Method of Operation

Assume that at zero slide position, the pickup coil voltage is exactly in phase with the power supply. If the slide is now moved a distance equal to ½ of the distance between the N and S poles on the scale (0.025), the two voltages will be opposite in phase, or in other words, there will be a phase shift of 180 degrees. A movement of 0.001 causes a phase shift of 7.2 degrees. Since a 1 degree phase shift is easily detectable, measurements to less than 0.00015 can be readily made. This phase angle difference signal can be read and used at all times, even when the slide is standing still. This feature permits stopping at any point in the cycle, manually retracting a slide as for a tool change, and then returning it to the previous position and continuing the cycle.

Measurement of the position of the slide with respect to its base is made directly and is unimpaired by wear, backlash, or errors in lead screws, nuts, racks, pinions, gears, or any other elements which are needed in other systems using rotating feedback elements.

Longitudinal positioning for the carriages is normally confined to half the accuracy and sensitivity of cross positioning. The space between N-poles on the longitudinal magnetic scale is 0.100 inch, and the pitch of the feedback generator screw is also 0.100 inch. This permits twice the feed rate longitudinally as cross-wise.

The playback head that interprets the command signals recorded on the magnetic tape contains a pickup coil wound on a core member that forms a closed magnetically conductive flux path between the tape and a rotating screw in much the same manner as in the feedback signal generator. The 0.050-pitch magnetically conductive screw is

must occur automatically can be accomplished by various means. The selection of spindle speed, feed rate, choice of cross slide cycle, choice of retract cycle, and other program functions which are to occur with a particular turret face can be made by means of dogs or buttons on a drum which indexes with the turret to actuate mechanical links, levers, valves, or limit switches. A simpler method of selection control is to use a system of preset selector or toggle switches. Position controls, such as the position at which "rapid approach" changes to "feed," must be accomplished by means of adjustable dogs or buttons on a drum which indexes with the turret and moves longitudinally with it.

A number of manual operations are required to set up a typical automatic turret lathe on a typical job. An operation sheet would most likely be prepared. For each operating turret face, in addition to setting tools for diameter, it is necessary to set them at the proper distance from the face of the turret. Also for each turret face, the dog or button that actuates the device for shifting from a traverse to a feed rate must be set, and in some cases a similar setting must be made for the end-of-cut position. If cross slide cuts are to be taken, either simultaneously with the turrent or immediately following, similar settings must be made for cross slide position stops or the cross slide operation must be correlated with the turret. Selections must be made (either by properly placing buttons on the function selector drum or by positioning selector or toggle switches) of spindle speed, feed rate, type of retract cycle, cross slide sequence, spindle direction, and other cycle programming functions to correspond with the requirements of the tooling on each face of the turret.

Fig. 2—Special analog computer-recorder is used in preparing magnetic tape. Auxiliary function commands are recorded as digital data; motion commands are recorded as analog signals.

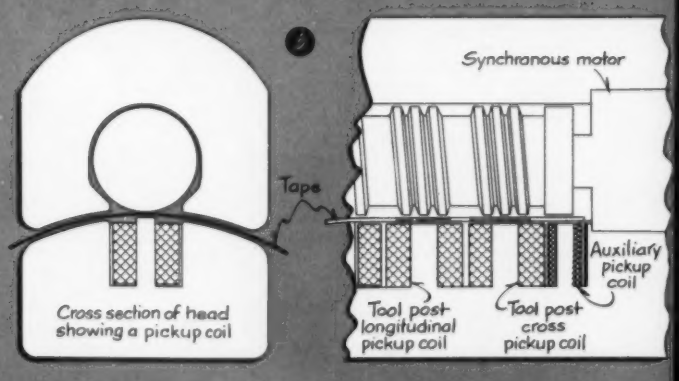
Once the position control drum and the sequence selector drum or switch panel have been set up for a particular cycle, the machine will reproduce that cycle much as a Swiss music box will play a particular tune when the prongs on its drum are arranged in a particular manner. Also, just as the music box can be changed to play a different tune by changing its drum to one with a different arrangement of prongs, the machine cycle can be changed to produce a different part by changing

mounted crosswise of the tape, *Fig. 3*.

As is explained in the Box entitled "Tape Preparation", flux lines on the tape are parallel to the length of the tape if no slide movement is called for. The flux lines are skewed left or right to indicate direction of movement with the degree of skew indicating rate of movement and length of skewed signal on the tape a function of duration of movement. When the tape is not moving, or when the magnetic traces are parallel, each revolution of the screw causes one cycle of ac voltage to be generated in the pickup coil.

When the screw is synchronous motor driven at 7200 rpm by the same 120-cycle ac power supply as is the screw in the feedback unit, a similar 120-cycle voltage is generated. This generated voltage is the command signal. It is compared with the previously described feedback signal by a phase comparator, and any phase difference between the two causes power to be exerted on the slide in the direction necessary to restore an in-phase condition. As an example, assume that the machine has been stopped and power removed while part-way through a cycle. Assume that while power is off, the cross slide is bumped and moved 0.010 inch. When power is restored, the feedback signal will be 72 degrees out of phase with the command signal from the tape and as a result power to correct the error will immediately be applied to the slide.

When the tape is moving through the playback head and the magnetic traces are skewed, the voltage generated by the pickup coil is no longer at a frequency of 120 cycles


Synchronous motor
Tape
Auxiliary pickup coil
Tool post longitudinal pickup coil
Tool post cross pickup coil
Cross section of head showing a pickup coil

the control drums. The storage of complete control drums for a particular job to reduce setup time has been done in many instances. This becomes quite costly and involved as the number of different jobs increases, particularly if many tool changes must also be made.

▶ Improved Control

The use of tape for machine controls has resulted from attempts to find simpler and more complete means of storing setup information than by preset control drums. For example, it is relatively simple to have a certain arrangement of holes in a tape cause a certain relay or switch to be energized. This might be the relay that selects the proper spindle speed. In this same manner a system of holes in a tape can be used for determining all of the variable program functions relating to the tooling on one face of a turret, such as spindle speed, feed rate, whether or not a dwell should take place before retract, whether or not coolant should flow during the cut, etc. Then, as the turret indexes, a new block of tape can be used to energize all of the proper relays for the program functions relating to the next turret face, and so on. It is thus possible to eliminate the need for the sequence selector drum or program switch panel on the machine and obtain easy storage and quick setup of cycle information for many different jobs on tape.

Please note, however, that a program tape, as just described, does not provide means for controlling the position at which a shift from a traverse to a feed rate takes place. It would still be necessary to have a position control drum indexing with the turret and moving longitudinally with it on which dogs or buttons would be set for all controls relating to turret position. So far as manual operations are concerned, to set up a typical job would still require an operation sheet. The time previously used in setting up a sequence selector drum or program switch panel would be saved. Other than that, the setup would be the same and the machining time would be the same. One essential difference is that speeds and feed rates as selected by the planning department, which makes the tape, must be used. The setup man has no control over them or over the other cycle program functions. Any change necessary requires a new tape. Close production control is thus provided.

▶ Position Control

To completely eliminate setup, except for tooling, it is necessary for the tape system to also include means for position control. One way is to use the tape as a template, move it through the tape reader at a speed proportional to the rate of travel of the turret, and have a certain arrangement of holes at a specific distance from the beginning of travel actuate a relay which causes the shift from traverse to feed rate to take place. This is perfectly satisfactory if the accuracy with which the position must repeat is no greater than about ±0.015 inch. But the end-of-travel position usually must be held to a much closer tolerance than ± 0.015 inch, often to ±0.0005 inch. Using the tape as a template would not be satisfactory unless the limitation on accuracy is overcome by such techniques as always feeding to the end of the travel provided by the slide cam and setting the tools accordingly. If limitations can be overcome, the tape effectively replaces the position control drum as well as the program control system.

In order to use tape information for position control to accuracies of 0.001 inch or better, additional equipment is necessary. In the first place a system must be set up whereby a given arrangement of holes punched in the tape represents the discrete position along the axis of the slide at which move-

per second but at a higher or lower frequency depending upon the direction of skew. If a constant angle of skew representing 1 inch of slide travel in 6 inches of tape is used, and the tape travels at 6 inches per minute, the generated voltage is either at approximately 119-2/3 cycles per second or 120-1/3 cycles per second. Since the tape recorder automatically records this amount of phase shift gradually rather than instantaneously, the system has time to respond and start the slide in motion before the complete phase shift of 1/3 cycle, or 120 degrees, has taken place. By the time the 120-degree phase shift portion of the tape reaches the playback head, the slide is already in motion, and the feedback unit is probably measuring within 1 or 2 degrees of the same angle as the command signal. Similarly, at the end of the called-for movement when the magnetic traces on the tape straighten out, they do so gradually, and the feedback signal is then restored to 120 cycles per second within milliseconds of the same instant as the command signal.

It is important that the actual phase difference between the command and feedback signals at all times be less than ¼ cycle or 90 degrees as the system becomes unstable when the error signal exceeds that amount. In actual practice, the phase angle difference is never permitted to exceed ±75 degrees. The system includes a safety circuit which constantly monitors all error signals and stops the machine cycle whenever the phase error exceeds 75 degrees.

Both the command and the feedback signals are of the same general type and of substantially the same order of magnitude (from 50 to 100 times greater than that used in other magnetic tape systems). This contributes toward a simplified control system. Both sets of signals are increased in strength by similar transistor amplifiers and then are directly compared by a method which discounts actual signal strength and is merely phase conscious. If the signals are in phase, there is no output. If there is a phase difference, a dc output proportional to the amount of phase difference results. This error signal is amplified and used directly to control the direction and amount of flow of high pressure fluid through electrically actuated servo valves to the operating cylinders. The amount of power under control and the responsiveness of the system are such that a 7.2 degree phase shift, which represents 0.002 inch of longitudinal movement, is corrected by the application of a 5000-pound force in less than 1/30 of a second. The frequency response is more than adequate for duplicating any contour which can be recorded using speeds and feeds normally encountered in turret lathe work.

ment is to stop. It is also necessary that the system have some means of converting the special arrangement of holes into an electrical signal or a combination of signals that total an electrical quantity or in some way specify an exact or specific electrical value which signifies the particular position and no other.

Another system necessity is a means of electrically measuring the position of the slide or the distance it moves from its zero position. There are a great many devices available for this purpose. A few provide a signal that is unique for a specific position of the slide at any point in its travel and permit the construction of an "absolute" measuring system. In an absolute measuring system, when properly adjusted and calibrated, if the electrical signal from the position pickup unit is compared to the electrical signal previously set up from the tape signal, they will agree in only one place.

Whether or not agreement exists between the command signal and the feedback signal is determined as the two signals feed into a unit of the control system which may be called a "comparator," a "mixer-discriminator," an "error detector," a "phase comparator," an "adder," a "synchronizer," or a "phase-difference discriminator" depending upon the type of signal and the type of control system used. Whenever the slide is not at the command position, there is a difference between the two signals which the comparison unit converts into the necessary power to drive the slide toward the specified position. When the command position is reached and no signal difference exists, the next step in the preselected program automatically takes place.

Means for driving the slide can be any of the driving devices normally used, such as a hydraulic piston-cylinder unit or an electric or fluid motor driven cam or screw. For the relatively short travels required on a turret lathe and because of the problem of closely controlling feed rates over a range from almost zero to about 30 inches per minute while still providing a traverse rate of up to 200 inches per minute, the hydraulic piston drive is preferable.

Co-ordinated Control

When two-axis positioning is required, as in a cross-feeding turret, additional complexities arise. Assume that a turret is at its "home" or zero position when the centerline of the turret is on the centerline of the spindle and the carriage is completely retracted. If we want to traverse forward to position a tool ready for taking a cut at a point that requires both movement forward of center and toward the spindle, it is necessary to record both dimensions and to designate which of the dimensions apply to cross movement and which to longitudinal movement. It is also necessary to designate whether the cross movement should take place before the longitudinal movement or vice versa, or whether to move in both directions at the same time. This consideration could be very important, for example, if the proposed cut consisted of back-facing in a bore behind a shoulder.

When taking, say, a boring cut, it may be necessary to maintain the position of the cross slide against heavy tool pressure in order that a straight bore results. One method of doing this is to have the

TAPE PREPARATION

AS with all numerical control systems, critical steps in the application of the Factrol control are organization of the data pertaining to positions and auxiliary functions and the recording of the data for machine use.

Procedures followed for the Factrol control can conveniently be explained by reference to a hypothetical operation, *Fig. A*. With reference to the Steps enumerated in *Fig. A*, the program sheet, *Fig. B*, indicates how the information would be organized prior to tape preparation. It will be noted that desired auxiliary functions associated with any step are entered before positioning instructions.

Step 1 is divided into Operations 1 through 4. In Operation 1, "Spindle Forward" calls for rotation of the spindle in the forward direction; entry of the zeros in the Co-ordinate Change Points column establishes the origin point of the tool. Co-ordinate points can be entered as absolute (relative to 0) or as a differential measured from a previous co-ordinate; depending upon this distinction, dimensional data are entered into either Line A or Line D in the Co-ordinate Change Points column.

Operation 2, "Spindle High," establishes that the desired spindle speed is in the high range. Operation 3, "Spindle Speed 2," represents a choice of a certain precoded spindle speed in the high range which the machine is capable of delivering. This speed might only approximate the desired speed.

Operation 4 includes the first positioning command. "Feed Traverse" entry in the Auxiliary Operations column indicates that the traverse rate is desired in traveling from the origin to the first point. As a built-in feature of the system, traverse rate is a pre-established function (10:1) of maximum feed rate, hence the designation "Feed Traverse." By entry of the arrow and 8-degree figure in Direction and Angle of Movement column, the programmer has indicated the approximate direction the tool must move to proceed from its origin to Point 1 (X = 12.345, Y = 1.750). Entering both "X" and "Y" in the Curve Radius and Rotation column indicates that movement along both axes is required. The 10 in the Feed column represents a feed rate of 10 inches per minute (maximum available) and since "Feed Traverse" has been specified, a traverse rate of 100 inches per minute will be obtained. End co-ordinate points are entered in appropriate columns.

Step 2 includes two operations, 5 and 6. Operation 5, "Feed 1," indicates only that a feed rate will be recorded. Operation 6 calls for the turret coolant flow to be activated and in the several columns under Turret, data are entered that establish the feed rate to be recorded. It is seen that a directional arrow has been entered with motion along X-axis only at a rate of 3.3 inches per minute. The 3.3

cross slide positioning system constantly energized so that if the slide moves away from the designated position the feedback signal becomes different from the command signal and the error detector immediately provides the necessary power to drive the slide back to the specified position. Assume that the feedback element used is capable of distinguishing errors of ±0.001 inch. It is then entirely possible that the tool would move back and forth a distance of 0.002 inch many times during the cut, resulting in a bore that could vary in size by 0.004 inch. This in itself might be permissible, but the fact that the best possible finish obtainable under these circumstances would likely be about 400 micro-inches is not permissible. Even the most sensitive and precise position transducer available when used with the fastest acting system possible to build would probably not maintain a position with sufficient stability to produce a real good finish. Accordingly, other methods of holding a programmed position, once reached, must be found.

If the drive to the slide contains little backlash and the system frictional load is quite high, it might be sufficient to merely remove the driving power when reaching a specified position in one axis while movement continues in the other. Many numerically controlled positioning tables on vertical drills or boring mills are operated satisfactorily in this manner. The component of forces in a direction to move the work table resulting from the tool loads involved on machines of this type are, however, quite small compared, for example, to the force tending to move a cross slide back when a turning tool is taking a $\frac{3}{8}$-inch deep cut in steel at a coarse feed. This is especially true when the stock removed is uneven or interrupted. Accordingly, it is advisable to provide a more positive means of maintaining position for a cross feeding turret or universal tool post.

If in the previous assumption the driving device is a motor of some kind operating through a considerable gear reduction, it is possible to prevent back movement by applying a brake at the motor at the instant driving power is removed. This would

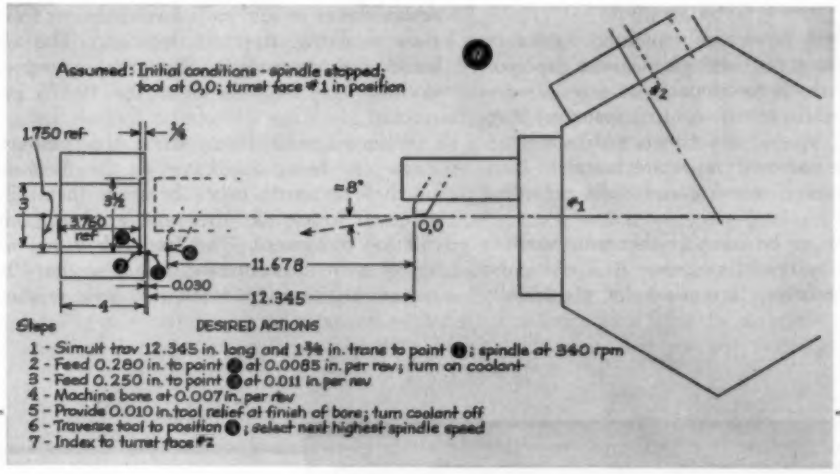
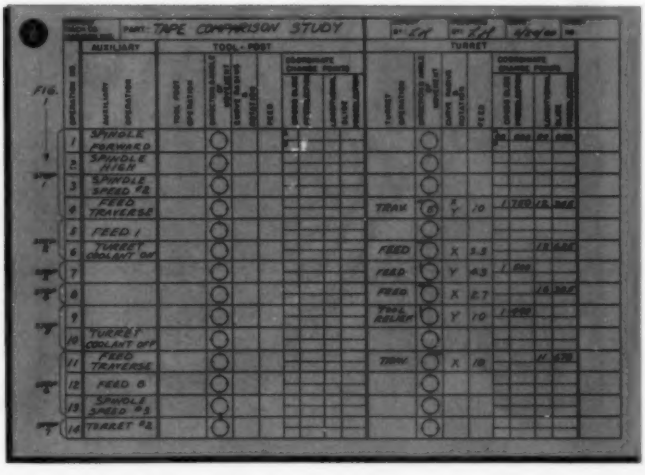

Assumed: Initial conditions - spindle stopped; tool at 0,0; turret face #1 in position
1.750 ref
≈8°
#1
#2
0,0
11.678
0.030
12.345
4
Steps
DESIRED ACTIONS
1 - Simult trav 12.345 in. long and 1¾ in. trans to point ❶; spindle at 340 rpm
2 - Feed 0.280 in. to point ❷ at 0.0085 in. per rev; turn on coolant
3 - Feed 0.250 in. to point ❸ at 0.011 in. per rev
4 - Machine bore at 0.007 in. per rev
5 - Provide 0.010 in. tool relief at finish of bore; turn coolant off
6 - Traverse tool to position ❶; select next highest spindle speed
7 - Index to turret face #2

figure was obtained by calculations involving the desired feed rate expressed in inches per revolution and the spindle speed previously programmed in Operation 3. The dimensional data entered under Co-ordinate Change Points define the co-ordinates that the tool will reach at the completion of its movement.

With this discussion as a background, the significance of the remaining entries on the planning sheet are apparent. To a great extent, the format and data are dictated by the type of equipment or method used in preparing the tape. As the method of recording the programmed data on magnetic tape is discussed, it can be seen how the organization of data simplifies the recording task.

Tape is prepared by means of a special analog computing and recording unit, *Fig. C*. Auxiliary operations, listed on the left-side of the planning sheet, are entered into the recorder by means of the keyboard shown at the left. The keyboard contains two columns of keys, each column consisting of 9 keys. Keys in the left column are identified by such words as Turret, Tool Post, Feed Rate, Turret Coolant, etc. Keys in the right column are identified by both numeral designations and/or words such as On, Off, High, Traverse, etc.



not, however, prevent further forward movement under the circumstances of a cut in which there is a tendency to pull the tool into the work, since a large gear reduction is necessarily accompanied by considerable backlash.

Probably the most effective means of maintaining a desired position is to apply a clamp directly to the slide. It must be done rapidly so that no movement can take place between the removal of driving power and the gripping of the clamp. It must be done in such a manner that no movement of the tool carrying member occurs as a result of clamping action. The clamp must instantly release when continued motion is called for, and it must not add materially to the system friction during movement. Preferably it should occupy a minimum of space, be simple in construction, and not require a large amount of power for its actuation.

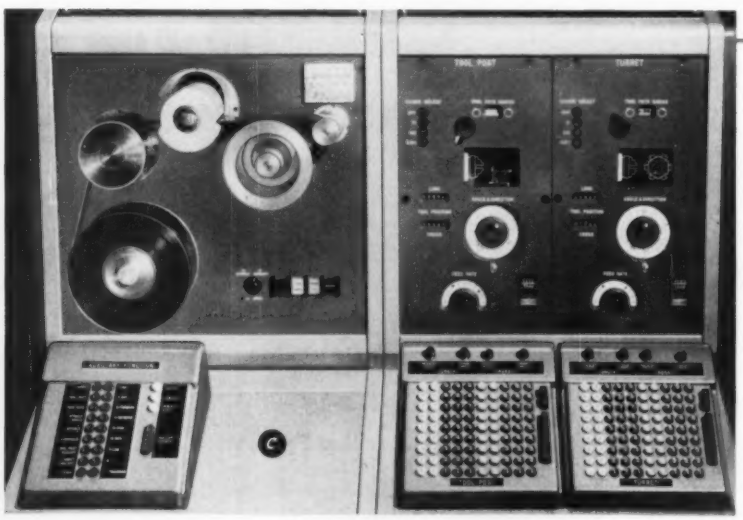
Magnetic Tape

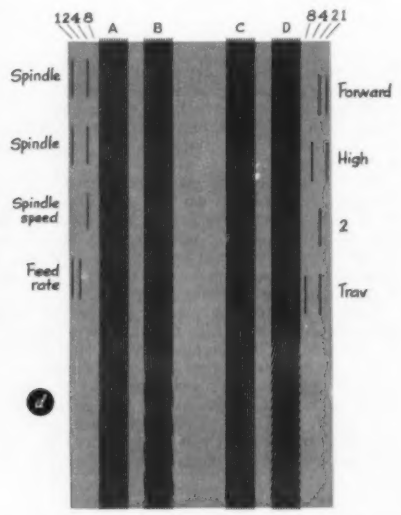
Though punched tapes are a popular media on which to record input instructions, magnetic tape possesses attributes which recommend its use in many types of data handling and control systems. Magnetic tapes of ¼, ½, ¾, and 1-inch widths are primarily used. The narrower tapes are found in communications, television, movies, and radio recording and playback.

Magnetic tape can be used in the same manner as punched tape by recording pulses in a particular code. Usually, however, it is used for continually recording multiple occurrences in exact time relationship to each other. In missile testing, for example, the same tape can simultaneously record vibrations, temperatures, pressures, forces, motions, numbers, etc. These data can be recorded at a fast tape speed and played back at a slow tape speed so that multiple events which take place in one second can be closely observed over a period of several minutes. Similarly, a slowly changing signal can be recorded at one speed and played back at a much higher speed through a system which uses this signal to control a position and thus obtain great positioning accuracy. Most machine tool control applications involve 1-inch wide tape on which up to 14 tracks of information can be recorded. Machine tool control systems which use magnetic tape are designed primarily for producing contours and irregular shapes such as wing spars, dies, etc.

In punched tape positioning systems as previously described, the movements take place in a series of jumps, so to speak. For example, if a turret is to move from its zero position to a position 10.375 inches away, the number 10.375 is read from the tape. The feedback signal (zero) is compared with the command signal (10.375). The control system senses the error and calls for movement in the direction to bring the two together. The movement starts and proceeds at the programmed rate, and nothing else happens until the 10.375 position is reached.

With magnetic tape control, the command signal starts out being the same as the feedback signal so that no error exists between them. Then the magnetic traces on the tape gradually change to call for movement. The feedback signal no longer agrees with the command signal so that the control system begins to put out power in a direction to





bring them back together and slide movement starts. As long as the command signal continues to call for movement, the slide will follow close behind.

In some systems the command signal consists of a shift in phase from a reference signal and the feedback is a similar phase signal. At standstill, the phase angle of the command signal, the reference signal, and the feedback signal are all alike. When the command signal starts to shift, the control system senses that the feedback signal is no longer in phase with the command and provides power to move the slide in the direction to bring the two signals back in phase. As the command signal shifts a total of 360 degrees, or one revolution, movement of a definite amount, such as 0.1 inch, should take place. Each 0.001 inch is 3.6 degrees of phase shift. To obtain a movement of 10.375 inches, 103 revolutions plus 270 degrees (75 x 3.6 degrees) of phase shift are recorded on the tape. This cannot be done in one step as with punched tape, but must be spread over a length of tape. The minimum tape length to record a distance of 10⅜ inches of movement with the standard 1 inch-14 channel tape system would probably be several hundred feet.

Principles underlying magnetic tape recording and playback permit a variety of approaches to applying magnetic tape in control systems. An example of a different approach is the Factrol system, offered by Gisholt. The concept of the Factrol principle of positioning control is over 15 years old. Originally light beam traces on a moving film were used as a means of storing information for conveying the message as to direction and rate of travel of a moving slide. Traces parallel to the length of the film indicated no movement. Traces skewed to the left signalled movement to the left, and vice versa. When, for many reasons, this method was abandoned and the concept of magnetic traces on tape was explored, there was very little prior art from which to draw knowledge. Only narrow, single channel, magnetic tapes were then in use, and their use was confined to the recording of music and voice for entertainment and broadcasting. The low energy level used and the nonuniform energy distribution of the tape signal was entirely inadequate and unsuitable for machine control purposes.

The system of magnetic recording, playback and feedback that was subsequently developed for Factrol incorporates in each unit a rotating element that provides dynamic electrical signals even at slide and tape standstill, see Box entitled "Principles of Operation." The command and feedback signals are of an identical nature and can be compared directly, resulting in a system that is simple and compact. Tape signal strength is so high that a minimum of amplification is needed and extraneous fields, pulses, or electrical phenomena which occur in a machine shop have no effect on the signals picked up by the system. Even dirt and metallic chips have been run through the playback heads and have become impregnated into the tape with no evident deterioration in the results obtained.

Because of the information density on the tape and the dynamic electrical signals resulting from the use of the rotating element in the pickup head, relatively short lengths of tape are required. On a job where the standard commercial magnetic tape system is used such as requires over 3000 feet of 1-inch wide magnetic tape for an operation, the Factrol system would require less than 30 feet of 2½-inch wide tape. The use of rotating elements in the Factrol tape system necessitates a wider signal track and more space between tracks than the conventional system and also requires through-the-tape magnetic signals instead of signals on one side only. It is for these reasons that the system does not use 1-inch wide tape as do most other magnetic tape machine tool control systems, but instead uses a

Recording auxiliary operations from the planning sheet requires that one key in each of the columns be depressed in order to define a desired operation. Following a selection, the actuator bar at the right-side of the keyboard is depressed, causing the desired operation to be recorded on the magnetic tape as the tape winds beneath a recording head (upper left, *Fig. C*). Auxiliary function data are shown as short vertical lines along both edges of the tape, *Fig. D*. As is indicated, the information is coded in binary coded decimal form (8421).

Fig. D also shows the four tracks of recordings representing motion commands (identified as A, B, C, and D). The two tracks at the left are concerned with transverse motion of the tool post and turret; the two tracks at the right are concerned with longitudinal motion of the tool post and turret.

The role of the recorder is to accept positioning data listed on the programming sheet and to translate and record these data as a certain pattern of closely spaced magnetic traces on tape. Essentially, the command patterns are created as disturbances to a trace of lines "normally" parallel to the edge of the tape. When played back at the machine tool, circuits provide that so long as the traces are parallel to the direction of tape movement, no motion is called for. When the traces are askew to the direction of tape travel, a signal is created that is interpreted by the machine tool as a motion command. Thus, the direction of skew, the angle of skew, and the length of skewed signal on the tape are the variables which are manipulated by the recorder in creating an analog command signal from digital data as entered on the planning sheet.

Motion data are entered into the recorder by the various dials and keys shown on the right of *Fig. C*. Two input units are indicated—one for the turret, the other for the tool post. With reference to the Operation 4 on the planning sheet, *Fig. B* data would be entered into the recorder as follows:

By means of a knob, arrows on the circular scale on the face of the recorder would be set to indicate an angle of 8 degrees with respect to the longitudinal axis and in a direction to indicate movement of the turret towards the headstock. Next, both *X* and *Y* keys (upper right) would be depressed on the turret keyboard. Returning to the recorder panel, a feed rate of 10 inches per minute would be set on the semicircular scale by means of a knob. The set of coordinates representing the end point of tool travel are then entered on the keyboard. With the dials set and keys depressed, the Actuate bar is depressed and actual recording on the magnetic tape commences.

For this command, the tape drive accelerates to the traverse recording rate, and position counters are actuated to follow the unit dimensions being recorded. As the counters accumu-

2½-inch wide magnetic tape. How data are organized on the tape is shown in the Box entitled "Tape Preparation."

An existing machine tool design typically requires some modification to adapt it for numerical control. For example, the Model 101 Factrol automatic turret lathe is built from a standard bed and headstock with some minor modifications to provide mounting pads and to obtain positive, rapid gear shifts. However, for a number of reasons, the tool post, the turret, the cross slide, and the carriages are particularly designed for numerically controlled use. Automatic power index of both the tool post and the turret is required which necessitates special cross slide construction. The power devices for moving slides and carriages are hydraulic cylinders instead of aprons and feed rods.

Since the tooling methods used on a machine of this type are similar to those for a tracer lathe, it is desirable to use relatively standard tools that remain in the same location for a wide variety of jobs and are called upon as needed. It is also desirable to have these tools index to the operating position in the shortest possible time. Since turret face No. 6 might follow No. 1, or vice versa, index in either direction to get there by the shortest path is important. The indexing mechanisms for both the tool post and turret are therefore designed to do just that.

In a manually operated turret lathe, and to some extent in automatic turret lathes, there are things that the setup man and the operator can do to compensate for known index errors and still produce work within tolerance. For a tape controlled machine, such manipulation is not feasible; the accuracy and repeatability of tool post and turret index must be as nearly perfect as can be obtained. For this reason a very positive and repeatable clamping and locating method was adopted. Each indexing member is located in the correct angular and vertical position by a pair of rings, one solidly mounted on the slide and other solidly attached to the tool post or turret. One ring has teeth and the other has mating sockets. A vertically acting hydraulic cylinder pulling downwardly with great force clamps the rings tightly against each other and positively maintains the alignment obtained by the interlocking teeth. When indexing, these cylinders raise the members enough to clear the teeth. Tests have indicated barely discernable variations in the position of a bar at an 18-inch radius from repeated indexes using a "tenths" indicator.

Any servo device, such as a tracer controlled tool slide, will perform more satisfactorily and to greater accuracies if the slide guiding and driving means have as little variation as possible in frictional resistance to motion from standstill to top speed. This applies to an even greater extent when the servo device is tape controlled. Accordingly, the guides under the cross slides and carriages are fitted with strips of a specially compounded Teflon material which carries most of the bearing loads and results not only in low values of frictional resistance but in nearly the same friction at standstill as when moving. This contributes in great measure to the responsiveness of the system.

In a hydraulically actuated servo system it is essential to keep the column of oil between the servo valve and the power devices as short as possible. On the Factrol, manifolds are used right at the cylinders, and the servo valves are mounted on them so that only short oil ducts exist between the valves and the cylinders. These manifolds are also used to port fluid for actuation of turret and tool post index, to port coolant into a distributor for use with the tool presently cutting, and to provide channels for conducting wires to the various electrical devices. Telescopic piping is used to the moving members, not only for hydraulic oil, but for coolant and wiring as well. As a result, there are no flexible hoses, conduits, or pipes of any kind cluttering up the machine.

A discussion of the considerations that are involved in applying numerical control to a turret lathe can conveniently be ended by noting "why" numerical control is applied. In general the benefits to be realized are: 1. Setup time is reduced. 2. Setup accuracy is not determined to as great an extent by operator or setup man skill. 3. Program and position information can be stored for reuse much more easily than can control drums, cams, or templates used by a conventional system. 4. Assuming a verified tape, within the limits of tool wear, multiple numbers of a given part will be error free (besides the assurance of good parts, inspection is reduced to a minimum). 5. Machine tool utilization is high because operating speeds can usually be increased, and there is no lost time for in-process measurements.

late a total that approaches the numbers entered on the keyboard, the tape drive automatically decelerates until the exact numbers are reached, stopping the tape drive and clearing the keyboard.

As applied to a turret lathe, the Factrol system provides for automatic control of: 1. Selection of one of six tool positions in the turret having 8 inches of transverse travel and 38 inches of longitudinal travel. 2. Selection of one of four tool positions in a tool post having 11 inches of transverse travel and 38 inches of longitudinal travel. 3. Selection of one of 24 spindle speeds in a range from 18 to 1090 rpm. 4. Continuous-path position and rate control of both turret and tool post for simultaneous straight, taper, or contour turning (boring or facing) at feed rate selectable from 0 to 10 inches per minute. 5. Coolant flow control to each tool while cutting.

It has been recognized that despite the best of planning efforts, practical considerations might dictate minor revisions in the program as recorded on the magnetic tape. To that end, the machine tool is provided with manual controls by which the zero adjustments can be made. For example, such adjustments are provided for the longitudinal direction of each of the four tool post tools and each of the six turret tools in a range of ±0.250 inch. Similar zero adjustment is provided in the transverse direction in a range of ±0.125 inch.

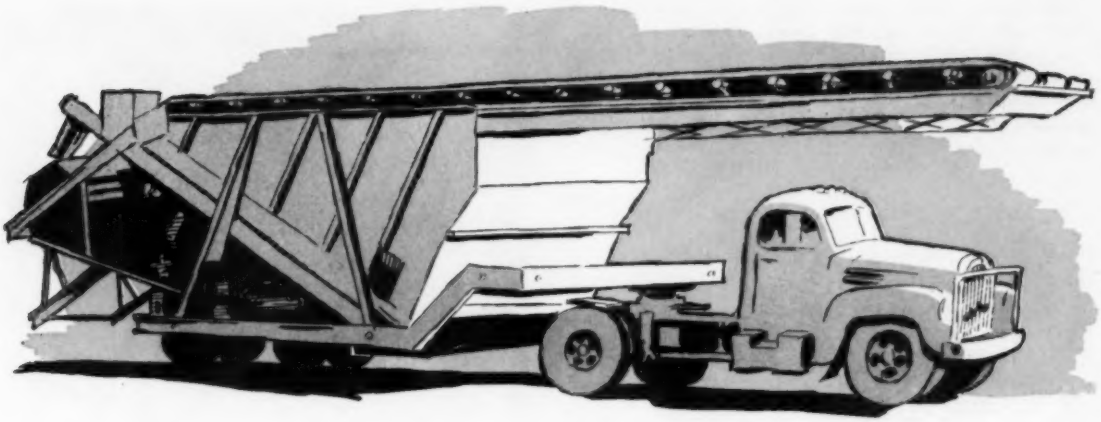


Fig. 1—Main section of mobile cement batching plant is easily transported by truck tractor. Highway speeds up to 30 miles per hour may be attained, and low over-all height of unit facilitates movement through cities. An accessory three-compartment aggregate supply bin is towed by a second tractor.

CONTROL FLEXIBILITY IN MOBILE BATCHING EQUIPMENT

READY-MIX concrete for delivery to construction jobs in transit mix trucks is typically obtained from one of two types of sources. For example, fixed batching plants may be used. Trucks pick up loads at the fixed plant, deliver mixed materials to the job, and return to the plant for more loads. In general, the trucking costs and number of trucks required for a given job depend upon factors such as average truck travel and wait times, the total yardage and pour rate required, and the capacities and rental fees for available trucks.

An economical alternate arrangement in some cases is the use of a portable batching plant that is set up and operated at the job site. This method offers the advantages of shorter mix hauling distances, better communications, and improved quality control on a given job. However, equipment moving, erecting, and dismantling costs may be considerable. Also, additional personnel and equipment—such as a batch operator and a front end loader and operator—may be required over and above the normal complement for a fixed plant.

A mobile batching plant developed by Heltzel Steel Form & Iron Co., *Fig.* 1, promises to greatly reduce the costs of transportation and setup for on-the-job concrete preparation operations. The plant contains built-in controls that facilitate efficient, accurate batching of a variety of concrete formulations in any desired sequence.

Transport and Setup

The mobile batching plant includes two major units—a main batching section and a three-compartment aggregate supply bin. Each unit is equipped with rubber-tired wheels and may be moved by a truck tractor. Upon arrival at a job site, the main batching section is spotted first. A hydraulic jack supplied with the unit facilitates lifting of each corner of the frame for leveling and blocking. Once the unit is blocked in place, the tractor may be driven away and the aggregate bin brought into position and blocked temporarily.

Raising of the batching section is possible after a connection has been made to an electrical power source. An electric motor may then be started to operate a hydraulic pump. When a valve is opened, the pump operates a telescoping cylinder to raise the unit, *Fig.* 2. Subsequent steps in erecting the unit include pinning of pipe support columns and bolting of two main columns.

After the aggregate bin is positioned and bolted to the main batching unit, the system is ready for

Fig. 2—When main batching section has been blocked and leveled at job site, unit is raised into working position by telescoping hydraulic cylinder supplied by Commercial Shearing & Stamping Co. Support columns are then fastened and drive belts on motor, left foreground, are shifted from hydraulic pump to air compressor as shown.

final adjustment and checkout. Typically, all of these make-ready procedures can be accomplished in less than three hours after arrival of the units at a job site.

Batching Operation

With the system checked out and supplied with materials, *Fig.* 3, batching may begin. Either of two batching methods—designated conventional and retrogressive—may be employed.

In conventional batching, the quantities of cement and aggregates comprising one batch are accumulated in weigh hoppers at the raised end of the main batching section, *Fig.* 4. The cement weigh hopper is a single unit. The aggregate weigh hopper is divided into three compartments so that each aggregate material may be placed in a separate section.

To load the cement weigh hopper, a batching operator starts a series of screw conveyors by means of pushbuttons on a control panel, *Fig.* 5. Cement is then moved from an integral cement bin (beneath the aggregate belt conveyors) to the cement weigh hopper. When the proper amount of cement has been placed in the hopper, as indicated on the dial of a scale, the operator stops the conveyors.

Each compartment in the aggregate weigh hopper receives material from an individual section of the supply bin by means of a separate belt conveyor. To accumulate a batch in the aggregate weigh hopper, each belt is operated in turn by a pushbutton. As an ingredient is placed in the hopper, the operator refers to the dial of a second scale and stops the belt when the desired quantity is fed. When all of the ingredients have been accumulated, gates are ac-

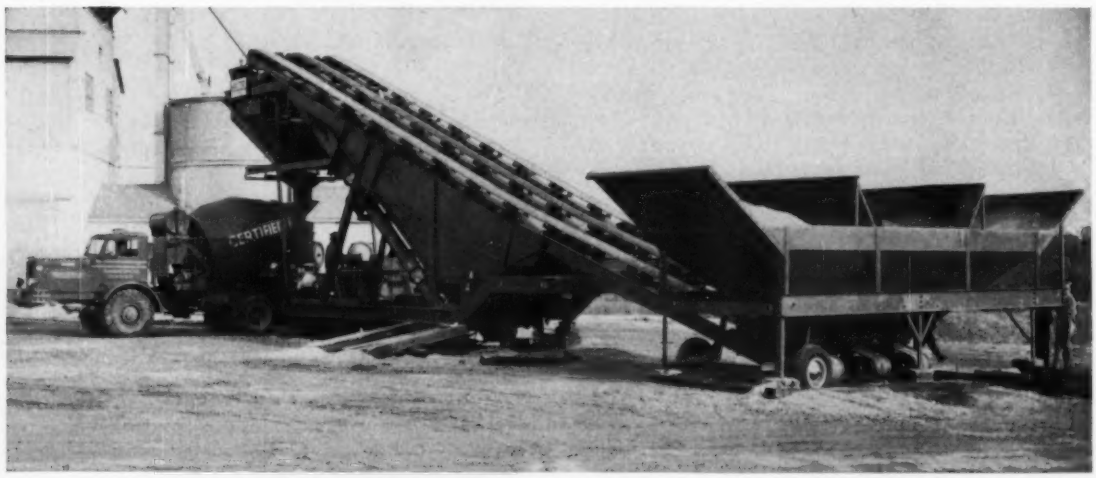


Fig. 3—Over-all view of cement batching plant shows 7-yard transit mix truck being charged. Three inclined belts at top of unit transfer aggregates from separate compartments of supply bin, right, to individual sections of weigh hopper above truck. Cement is conveyed from bin beneath inclined belts to separate weigh hopper by screw conveyors. Operations are controlled by batching operator on control platform at front of unit.

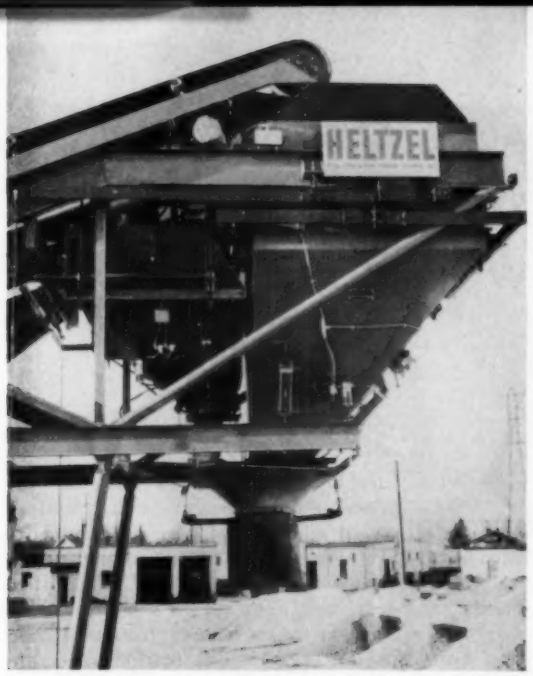


Fig. 4—Close-up illustrates weigh hoppers which discharge to common spout used to load transit mix trucks. Pneumatic cylinders operate a single gate on the cement hopper and three gates on the aggregate hopper to control dispensing of materials to trucks.

tuated to release the batch.

Retrogressive batching offers several time-saving advantages over conventional operations. In retrogressive batching, the weigh hoppers are first filled to capacity. In the case of aggregates, all three belts are operated simultaneously. As each compartment in the weigh hopper becomes filled, a Bin-Dicator Co. level control is actuated, and the belt supplying aggregate to that compartment is stopped. When the cement weigh hopper is filled, the flow of cement from the screw conveyors is automatically diverted back to the cement bin for recirculation.

With the cement and aggregate weigh hoppers filled, the two scales on the control platform are zeroed. This operation involves rotating an inner dial on each scale so that the zero point of the dial corresponds to the position of the pointer on the scale. For each scale, the pointer position represents the total weight of material in a hopper. This weight may be read on the outer dial of the scale as in conventional batching.

Each inner dial is calibrated to read retrogressively; that is, the amount of material removed from a weigh hopper may be read directly on the dial as the scale pointer moves toward its zero weight setting because of removal of material from a hopper.

To fill a transit mix truck with a desired formulation, the batching operator presses an appropriate pushbutton for each ingredient in succession. When a pushbutton is operated, a gate is opened to release the proper ingredient to the truck. By watching the scale pointers, and noting the weights on the inner dials, the operator can transfer materials from the weigh hoppers to the truck in any desired proportion.

As soon as material transfer has been completed, the weigh hoppers may be refilled by starting the inclined belts and cement screw conveyors. The hoppers will then be filled and ready for batching when the next truck is in position.

Water may be added to the mix in any truck. This is accomplished by setting a desired quantity of water on a meter dial. When the set quantity is fed, a valve closes automatically to stop the flow of water.

Each gate for a dry material (sand, two sizes of aggregate, and cement) is actuated by a pneumatic cylinder when a pushbutton is depressed. Compressed air for the cylinders, and for aeration of cement in the weigh hopper during discharging, is obtained from an integral air compressor system. The compressor is operated from the same motor used for elevating the unit by switching the flexible drive belts from the hydraulic pump to the air compressor.

Mobile ready-mix batching plants of the type described are available in several models. Units capable of handling three aggregates have batching capacities from 65 to 180 cubic yards per hour and recharging rates up to 900 tons per hour. Two-aggregate models are also obtainable. Variations of the basic design include mobile one and two-stop paving plants and central mix plants with one or two 3-yard mixers.

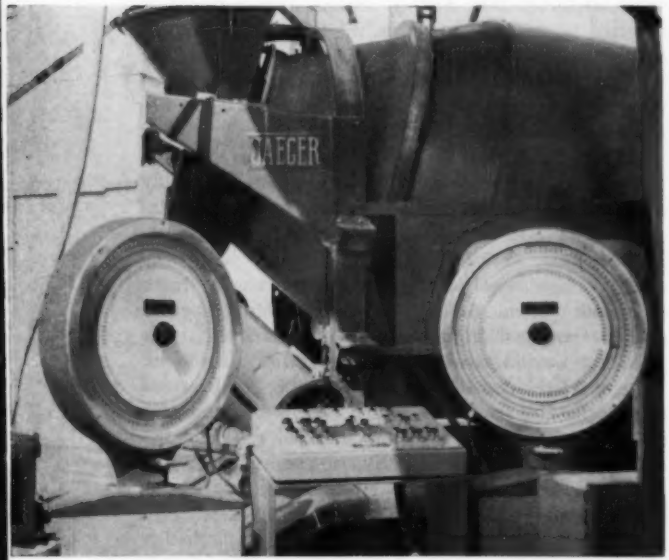


Fig. 5—Batching is controlled from pushbutton station on control platform. Scales, built by Howe Scale Co., are used to weigh contents of cement and aggregate hoppers. Inner dials on scales are used for retrogressive batching in which materials are weighed out as they are removed sequentially from filled hoppers. Conventional batching employs outer dials of scales to weigh desired quantities of materials into empty hoppers to form individual batches.

Fig. 1—Automatic assembly system prepares stators for alternators used in automobiles. Major units of system include multispindle coil winder, left foreground, stator slot insulator, left background, coil transfer unit and wedging machine, center background, and press forming machine, right background. Path of movement of stators is from left to right between stator slot insulator and press forming machine.

Fig. 2—Phase coils made from copper wire in multispindle winder, left, are placed on discs mounted on mandrels. When the three discs of a mandrel are filled with coils, mandrel and discs are transferred to horizontal track leading to expander area, right background, where coils are placed in stator slots.

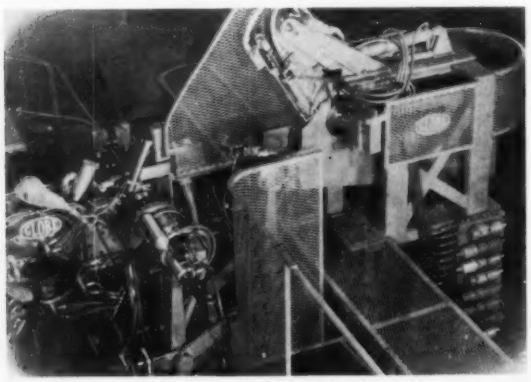


Fig. 3—Stators containing phase coils are moved to wedging station, center, where coils are wedged in place and then to press forming machine, right, for final sizing of the coils. Mandrels and discs from which coils have been removed are returned automatically on tracks to input side of coil winder.

AUTOMATIC ASSEMBLY SYSTEM PRODUCES WOUND STATORS

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Globe Tool & Engineering Co.
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WHEN the decision was made to use alternators in place of dc generators in the electrical systems of its automobiles, Chrysler Corp. was faced with several new production problems. For example, large quantities of alternators, built to high quality standards, were required. To produce these units rapidly and at lowest possible cost, the company turned to use of automatic production equipment.

Illustrative of the type of facilities employed to manufacture alternators is an automatic stator assembly system developed by Globe Tool & Engineering Co., *Fig.* 1. Functions performed by the system include insulating of the stator slots, winding and placing of phase coils in the slots, wedging the slots to hold the phase coils in place, and press-forming the windings compactly into the desired space.

In operation of the system, phase coils are automatically form-wound from copper wire in a three-spindle winding machine and placed on transfer mandrels, *Fig.* 2. Each transfer mandrel contains three workholding discs, and each disc receives six phase coils. When the discs of a mandrel have been filled with coils the mandrel is transferred to a track and moved to an expander area where the coils are withdrawn from the discs and placed in the slots of a stator.

Stators containing phase coils are next transferred to a wedging unit, *Fig.* 3, where strip material is inserted in the slots to retain the coils in the stators. Following this operation the stators are moved to a final workstation where the windings are press-formed to the desired size, and finished products are ejected automatically.

Actual production rate of the system has substantially exceeded the preproduction forecasts for steady flow operation. The system requires only occasional replenishing of wire, insulating, and wedging materials.

Production requirements dictate the use of more than one system. At first, the stators were inspected as they emerged from each system. Later, a single checking station was set up where stators from all systems were inspected. Products were color coded to identify the system on which they were produced. However, rejects were so few that color coding became unnecessary and, finally, in-line stator inspection was discontinued altogether. Defective stators are now detected during final assembly testing of complete units.

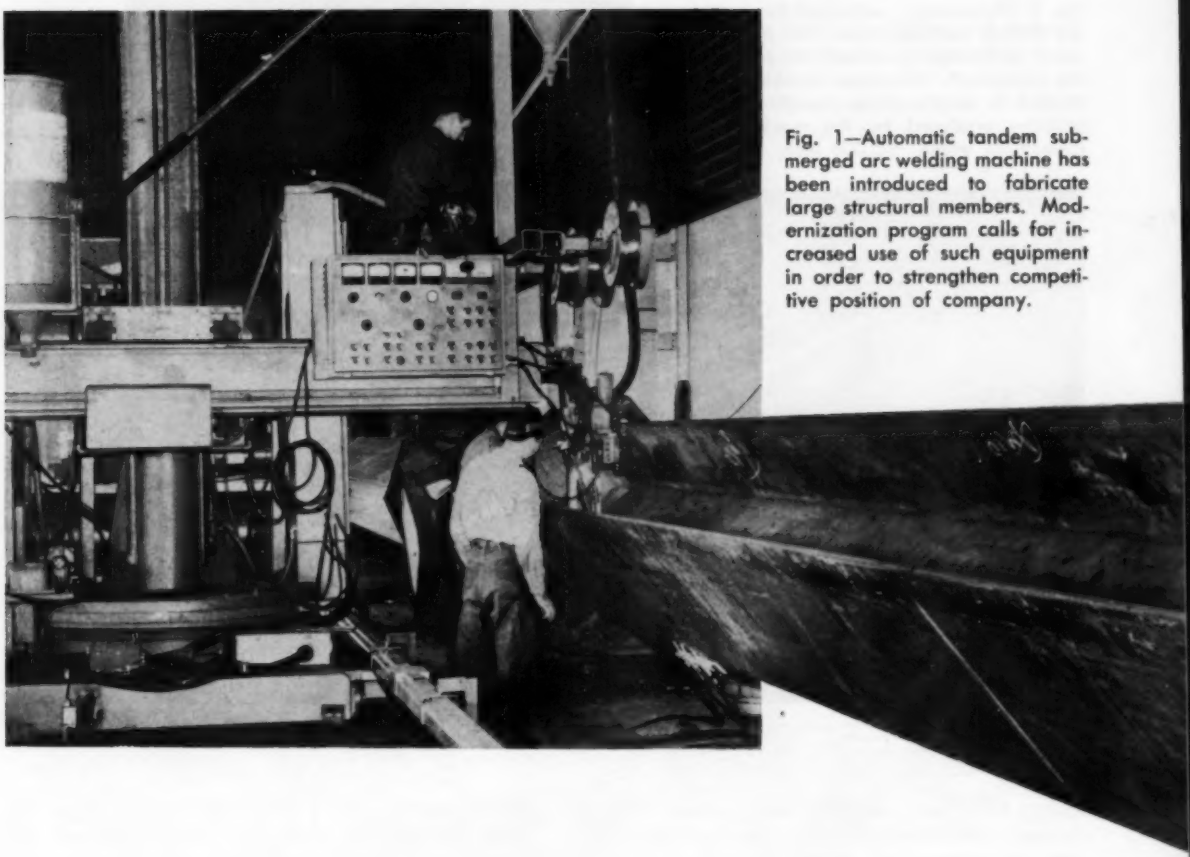

Fig. 1—Automatic tandem submerged arc welding machine has been introduced to fabricate large structural members. Modernization program calls for increased use of such equipment in order to strengthen competitive position of company.

STEEL FABRICATOR MODERNIZES LARGE SCALE JOB-SHOP

A BASIC tenet of the proponents of automation is that modern technology, wisely applied, can benefit all industries. Wise application requires a positive outlook—an objective search for those operations that lend themselves to automation. The fabrication of large structural members for buildings, bridges, etc., is a case in point. To some, fabrication of members for engineered structures might be thought of as an excellent example of a job-shop, with little probability of the repeat production believed necessary to support automation. Others might view the same production requirements as involving countless calculations, welding literally miles of joints, an almost endless production of holes, and repetitive painting requirements.

This latter viewpoint has enabled R. C. Mahon Co.'s Structural Steel Div. to realize such improvements in fabricating structural members as reduction in welding time of 80 per cent, cost savings of approximately 85 per cent in producing holes, and a 50 per cent reduction in the cost of painting. These improvements have followed completion of the first phase in the Division's multimillion dollar, 7-year production facilities modernization program, introduced 2 years ago.

During the next 5 years, the company plans to

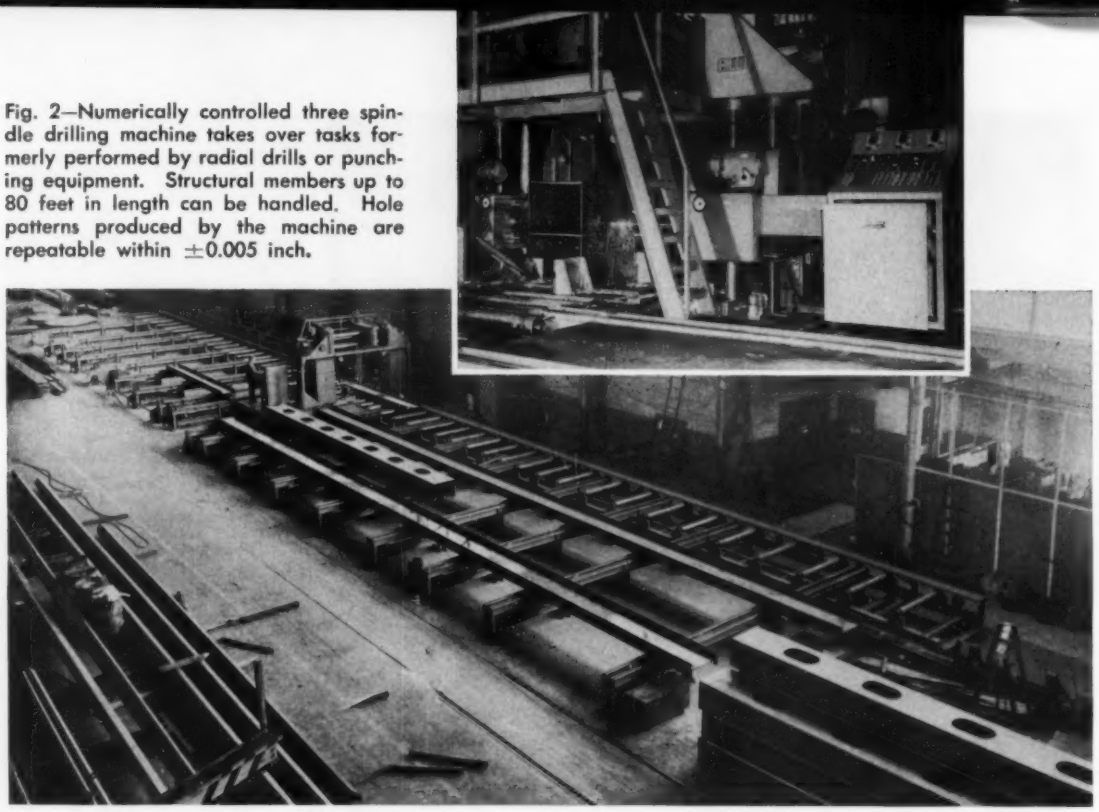

Fig. 2—Numerically controlled three spindle drilling machine takes over tasks formerly performed by radial drills or punching equipment. Structural members up to 80 feet in length can be handled. Hole patterns produced by the machine are repeatable within ±0.005 inch.

replace with new machinery the balance of all production equipment used in the Structural Steel Division. Aiming at both shorter processing times and lower costs, the plans envision a greater use of numerically controlled equipment, mechanized welding units, and modern materials handling and live storage techniques.

Savings to date have been demonstrated on the structural members currently being processed for the New Albany Bridge (a 1600-foot tandem tied arch, double deck structure designed by Hazelet & Erdal, consulting engineers). As regards production, this particular bridge is noteworthy because of the extent to which major components are designed for shop welding and subsequent field erection with high strength bolts. As an interesting aside, advanced technology began contributing to savings being realized for this bridge during the design stage. A large computer was used to speed up the mathematical calculations of stresses and deflections.

▸ Production Improvements

The improved paint system, developed by R. C. Mahon Co., is built around a large conveyor, 15 feet wide by 400 feet long, that extends from the erection floor, through a paint spray booth, and to an outdoor storage yard. The conveyor replaces a previous technique in which operators spray-painted structural parts lying on the plant floor—with attendant rehandling to turn parts over. With the conveyor system, parts are conveyed past two stations, one above and one below the conveyor, at a speed of 5 feet per minute to be completely painted in one pass. For average work, 200 tons of steel per shift can now be painted compared to 50 tons per shift with former practices.

The automatic welding equipment, *Fig.* 1, is an example of the type of equipment being introduced to effect fabrication savings. Compared to manual units, mechanized welders have been found to operate approximately twice as fast and larger tandem arc automatic units approximately five times as fast in laying comparable welds. The illustrated Lincoln Electric Co. tandem arc unit is mounted on a manipulator built by C. B. Herrick Mfg. Corp.

Determined by stock thickness, previous methods for producing holes in structural steel components included radial drilling and punching. These methods are being replaced by numerically controlled drilling machines—the initial acquisition being a special beam and column drilling machine, *Fig.* 2. Basically, the machine consists of a motorized run-in conveyor, a motorized feed roller conveyor, a high-speed drilling machine having two opposed single spindles and one vertical spindle, and a motorized run-out conveyor. The motorized feed roller conveyor and the three drilling spindles are automatically controlled by a punched tape system. As an integrated system, the machine typifies what can be accomplished by the co-operation of various manufacturers. For example, the drilling machine was developed by Walter P. Hill Inc.; the conveyor system by Cooney Industries Inc.; and controls by General Electric Co.

In operation, the structural parts to be drilled are loaded on the run-in conveyor by overhead crane.

Under control of the operator at the drilling machine, parts are fed one at a time onto the feed conveyor. The beam is advanced, hydraulically clamped, and drilled under tape control. To obtain a desired hole-pattern, the beam is moved longitudinally by the feed conveyor; transverse motion of the drill heads relative to the beam then locate the exact spots to drill. Movement along all axes is simultaneous. When the drilling of a part is completed, the beam is discharged onto the run-out conveyor where several can be stored for subsequent pick up by overhead crane and transferal to assembly bays.

▶ Design Details

Except for orientation, the three single-spindle drill heads are identical. The drive for each includes a hydraulic cylinder, ball bearing leadscrew, worm gear speed reducer, selsyn feedback unit, and a ¾-hp, dc positioning motor. The positioning motor is connected to the leadscrew through the speed reducer; the selsyn feedback unit is connected direct-

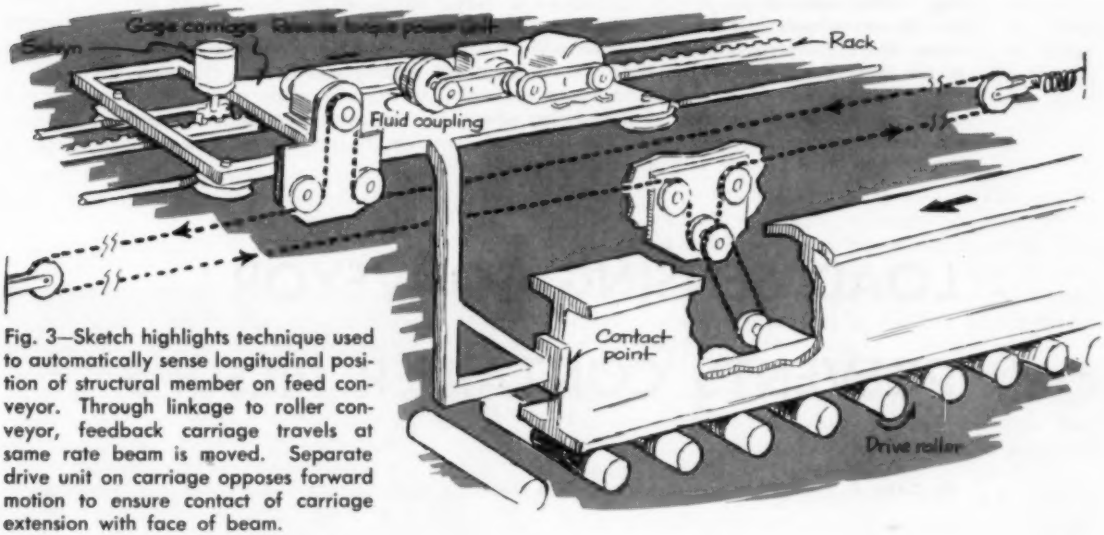

Fig. 3—Sketch highlights technique used to automatically sense longitudinal position of structural member on feed conveyor. Through linkage to roller conveyor, feedback carriage travels at same rate beam is moved. Separate drive unit on carriage opposes forward motion to ensure contact of carriage extension with face of beam.

ly to the leadscrew. A head is moved by actuating the positioning motor, which releases the leadscrew, permitting the hydraulic cylinder to provide the power to move the head. This hydraulic cylinder assist arrangement was developed by Walter P. Hill Inc. for use in conjunction with positioning control feed drives. When the feedback unit indicates the head is in its desired position, the positioning motor shuts off, locking the leadscrew to prevent further head motion. The hydraulic cylinder is pressurized while the leadscrew is stationary to take up all backlash in the system.

The numerically controlled feed conveyor can accommodate columns and beams up to 80 feet in length (could be 300 feet), positioning work such as to obtain hole patterns repeatable within ±0.005 inch. Controlled motion is obtained by a combination of a carriage for feedback control and a main conveyor roll drive. Conveyor rolls are powered by a continuous chain drive connected to a 7½-hp dc motor. Three preset speeds are possible: 600 ipm for maximum travel, 60 ipm for short distance travel, and 12 ipm creep travel.

The desired longitudinal position of holes is described relative to the leading edge of a workpiece. Thus the feedback unit must provide for the sensing of the actual position of the leading edge at distances up to 80 feet from the position of the drill spindles. To provide for sensing over this distance, a selsyn feedback unit is mounted on a carriage that travels on rails beside the side of the conveyor, *Fig.* 3. This selsyn is connected to a pinion which engages a rack mounted between the carriage rails. An outrigger extension from the carriage contacts the end of the beam, providing the means by which the feedback unit is "connected" to the surface whose position is to be sensed.

To overcome the obvious difficulties of a freely moving carriage, means are provided to control the carriage motion. An endless chain, driven by one of the main conveyor rolls, passes over a sprocket on the carriage. As the conveyor roll is driven to move a workpiece, the endless chain tends to drive the carriage at the same speed. To ensure that the carriage extension is in contact with the face of the workpiece, the sprocket on the carriage is also connected through a drive train that includes a fluid coupling to a ½-hp motor opposing the forward motion of the endless chain. The ½-hp motor provides sufficient torque to hold the carriage against the beam, ensuring contact, even though a workpiece might slip on the conveyor rolls.

The significant cost reductions in producing holes which have been obtained are attributed to the elimination of hole pattern layout operations, use of high speed drilling, and automatic handling into, through, and out of the tape controlled machine.

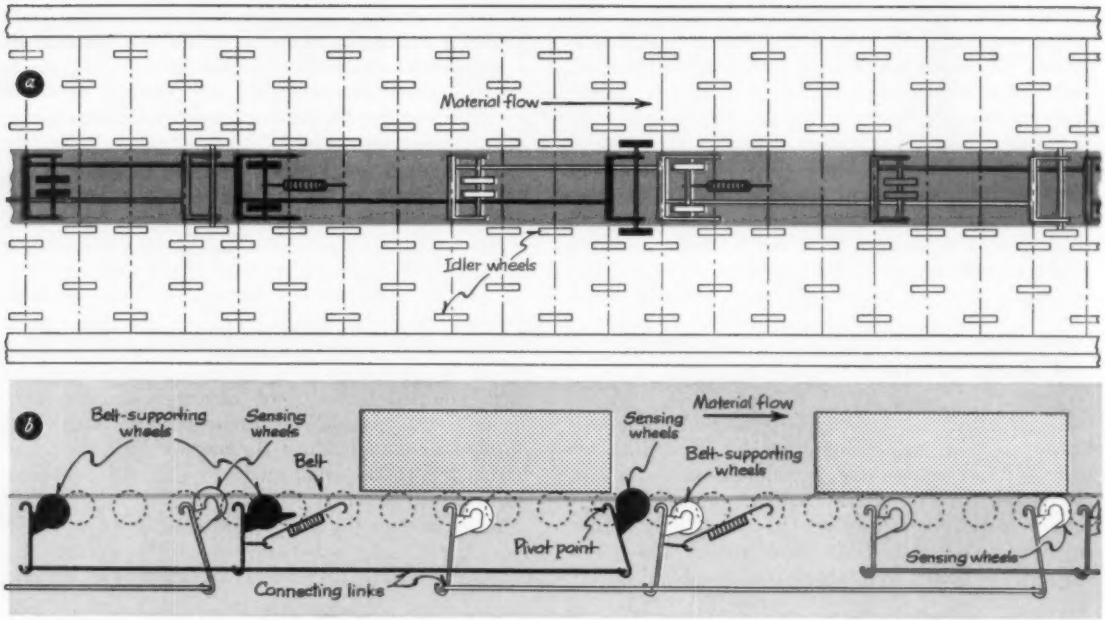

Fig. 1—Plan view of the Automatic Pressure Conveyor (a) shows the arrangement of the sensing wheels and the belt-supporting wheels. The idler wheels on the outer areas of the conveyor support the load while the sensing and belt-supporting wheels in the inner area provide a means for stopping and starting containers. Elevation view (b) illustrates how a leading container, right, temporarily stops a following container, center. Depression of the sensing wheels by the leading container causes the belt-supporting wheels under the following container to pivot and drop the driving belt from contact with the bottom of the unit.

LOAD SENSING CONVEYOR PREVENTS CONTAINER PILEUPS

By **CARL J. FALCON,** Manager of Product Design & Development Engineering, Rapids-Standard Co. Inc., Grand Rapids, Mich.

CONVEYING of packages or unitized items had its begining in the 19th century. At that time, industry was beginning to produce consumer goods that had to be packaged. As production methods improved, the efficient movement of unitized items away from the production areas became imperative. The earliest conveying efforts utilized the force of gravity in inclined chutes and troughs. In order to reduce the angle of incline necessary to overcome frictional effects, wooden rollers fitted with axle pins were developed. In both conveyor types a unit load will flow only if the gravity force component is greater than the total of all frictional forces in the conveyor mechanism. Since the conveyor is usually inclined at an angle greater than necessary to overcome frictional forces, a part of the gravity force remains as a force with the load. If the load is stopped on the conveyor line, this load force will be exerted against the stop. If there are a number of unitized items stopped behind the first, the resultant force against the stop will be proportionately greater.

Conveyors were later developed that no longer relied on inclined surfaces and the force of gravity. These conveyors could be used to transport materials along a level surface and consisted of a moving media powered from an auxiliary source. Probably the first of such powered units was a belt conveyor using leather belts. Later, chain conveyors and closely-spaced live roller conveyors were developed.

However, gravity and powered conveyors have one undesirable feature. If the production operation requires that the conveyed articles be stopped and accumulated without stopping the conveyor, the magnitude of the pressure against the stop device

becomes the sum of all the loads stopped times the coefficient of friction between the load and the conveying surface. This pressure is greatest on a belt conveyor, less on a chain conveyor, and least on a live roller conveyor. At times, the pressure against a stop can be great enough to crush a conveyed item or to cause a package to jack-knife upward and jam the conveyor.

It is frequently desirable to accumulate a train of unitized items and then to be able to remove an item from any place in the line for purposes such as sorting, marking, or performing work on the removed item. If the accumulation pressure is great, the removal of the item may be difficult and sometimes impossible. This negative feature of powered conveyors was always apparent, but has become more acute as improved machine productivity has increased the need for greater conveying efficiency and skills.

Our first serious attempt at developing a solution to this problem was undertaken at the request of a customer who desired to store palletized transformers weighing 500 to 4200 pounds on conveyors. Individual conveyor runs were long, and frontal pressures were very large. It was important that loads could be removed with ease while the conveyor was running, without damage to pallet or transformer.

We found no really good solution to this problem, but the net result of this project was a firm resolution that an answer must be found. Of the several approaches tried, one held good promise. This approach was a theory that the first article in a conveyor line must always be driven, wherever it may be on the conveyor, and that this article should control, or cancel out, the conveying force of a succeeding article for a predetermined distance. The ideal would be if this distance were equal to the length of the article transported. Under these conditions the pressure exerted by the first article would be the only force against a stop.

Fig. 2—At Poloron Products of Pennsylvania Inc. a double-decked APC system is used in the order selection area of a warehouse. Orders are picked from pallets on gravity roller live storage racks and placed on either of the two APC conveyors. At the end of the selection area, shown, the orders are automatically spaced out for delivery to two inclined conveyors leading to the shipping area.

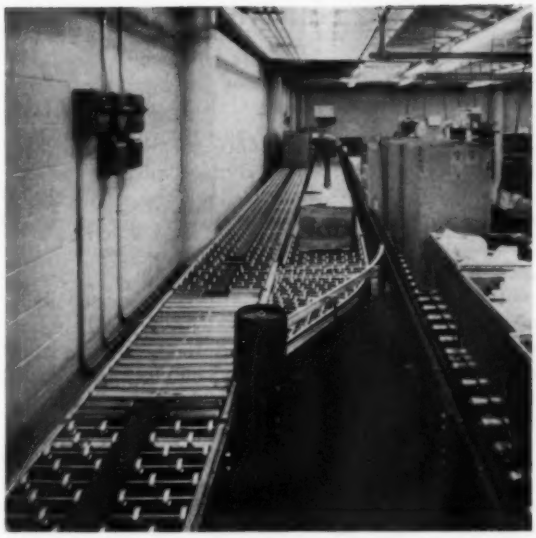

Fig. 3—Two parallel APC conveyors are used in the marking department of a large Eastern department store. Operators mark incoming merchandise and place it into cartons or tote boxes. When a container is full, the operator pushes it onto the live roller conveyor on the right. A dispatcher at the far end of the roller conveyor accumulates a train of containers on either of the APC conveyors and then sends it to proper sales floor.

Using this principle of operation, a new type of conveyor was developed by the Rapids-Standard Co. Inc. The conveyor, *Fig.* 1*a*, uses a narrow belt as a driving medium and a wheel bed for supporting the load. Two center bands divide the conveyor width into three areas. Steel axles, at 3-inch centers, support the nondriven wheels at intervals designed to form a wheel pattern for the adequate support and proper conveying of a given article. Wheels are omitted from the center area of the conveyor, and in their places are installed a narrow belt, belt-supporting wheels, and load sensing wheels.

The belt is held in contact with the underside of the article being conveyed by pairs of belt-supporting wheels. On either side of the belt at spaced intervals are mounted pairs of load sensing wheels which project above the belt so that they can be contacted by the bottom of the article being conveyed. Each pair of sensing wheels controls the upward pressure of two pairs of belt-supporting wheels. In the APC (Automatic Pressure Conveyor) design, a pair of sensing wheels is mounted between two pairs of belt-supporting wheels connected to the next pair of sensing wheels in the line, *Fig.* 1*b*.

When a single container is moving down the conveyor line, it will continually depress the sensing

wheels but will not stop since the belt-supporting wheels holding the belt in contact with the bottom of the container are controlled by the next pair of sensing wheels in the line. However, any container immediately behind the first one will be temporarily halted each time the leading package depresses a pair of sensing wheels, causing its connected belt-supporting wheels to pivot away from the belt and drop the belt away from the bottom of the second container. In turn, the second container will cause the belt-supporting wheels to pivot under the third container, temporarily halting this container, and this action continues for as many containers as are on the conveyor.

When the first container in the line is stopped, a similar action occurs. The first container depresses a pair of sensing wheels which controls the belt-supporting wheels under the following container. However, the first container still remains in contact with the driving belt since its belt-supporting wheels have not been pivoted. The second container in the line will be conveyed normally until it reaches the area immediately behind the first article. Since the belt-supporting wheels have been pivoted by the first article and the driving belt has been lowered, the second container will either come to a stop behind the first container or may glide up to the first article and touch it without pressure. The specific stopping distance between containers depends upon the belt speed, the weight of the object being conveyed, and the firmness of the container bottom. All following items in the line will stop in a similar manner until the belt is filled.

When the stop is removed from the first container, only the first unit will move. The second article will not move until the first unit has moved off the sensing wheels. This action provides a gap between the first and second containers equal to approximately the length of a container. In a similar manner, a gap is produced between all containers on the line. We have called this feature "singulation" as articles will move off a conveyor singly rather than in groups, and it provides several useful advantages. For example, it makes counting easier, spaced articles convey better on curves, articles can be removed from the conveyor anywhere in the line, and very fragile containers can be conveyed and accumulated without fear of crushing.

The APC principle has also been applied to live roller conveyors which can convey heavier loads or loads having bottom surfaces unsuitable for handling on wheel conveyors. In a live roller conveyor, the load-supporting rollers are driven by a moving belt which is held in contact with the undersides of the rollers. In the APC live roller models, another set of rollers has been added to press the belt to the undersides of the conveying rollers. Every fourth conveying roller is a sensing roller which is connected to a set of belt-supporting rollers at a predetermined distance behind the sensing roller. When an article depresses the sensing roller, it causes a set of belt-supporting rollers to lower, dropping the driving belt away from the conveying rollers. Therefore, the second article in the line stops until the first article moves off the sensing roller. The sequence of accumulation and singulation for the live roller models is identical to that described for the wheel conveyor system.

Both types of conveyors have been used where long accumulation conveyor lines are the rule. Two examples of their use are shown in *Fig.* 2 and 3. They are most successful in applications where the articles handled are uniform in size and weight and where the length of the article is nearly that of the spacing between the sensing devices. Using standard conveyor components, containers handled by the system may be as short as 9 inches or as long as 36 inches and must weigh at least 5 pounds individually or per foot and not over 50 pounds per foot. Conveying speeds range from 24 to 100 feet per minute.

are you stuck?

Since its inception AUTOMATION has helped increasingly in the solution of hundreds of widely diversified practical problems in making manufacturing operations more automatic. Regardless of the character of the operation or system being developed, somewhere in industry a similar problem has been solved and, very often, equipment is available from reliable builders or suitable techniques are known to specialists.

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RECIPROCATING BURNERS BRAZE HEATER ELEMENTS

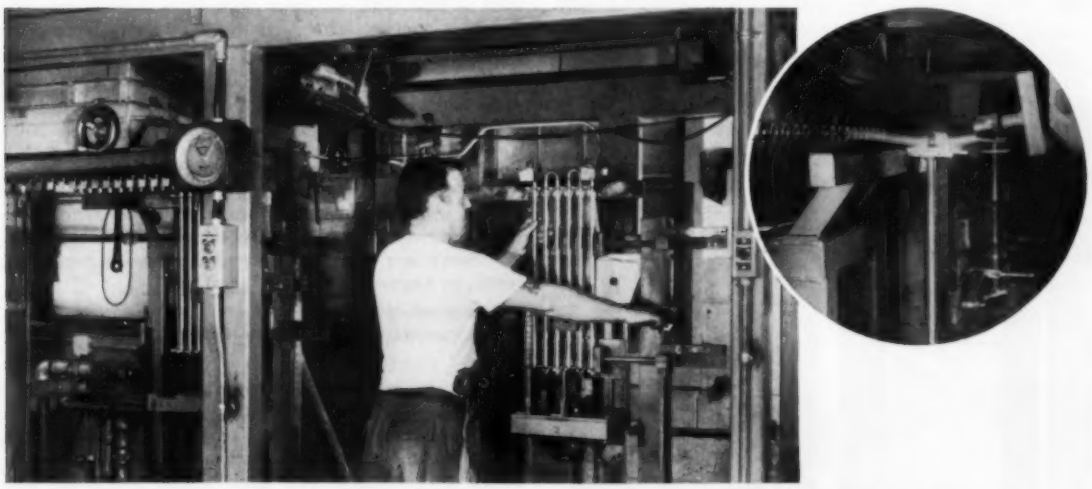
INSTALLATION of a mechanized brazing machine has enabled John J. Nesbitt Inc. to increase the daily production of copper tube heating and cooling elements from 40 manually brazed units to about 200 automatically brazed units. At the same time, accurate and uniform application of heat by the machine has reduced the number of assemblies that had to be reworked due to imperfections from about 23 per cent of production to approximately 2 per cent.

The operation involves silver-brazing copper return bends to both ends of copper tubes in heating and cooling elements, varying in shape and size, used in heating and air conditioning units. The previous manual brazing procedure consisted of cleaning the return bends with a detergent wash to remove grease, dipping the parts in Deoxidine to remove surface oxides, applying flux, positioning the bends into the tubes, and brazing the joints with a hand torch. After cooling, the assemblies were washed to remove flux residue.

By mechanizing the operation and using a silver alloy filler metal preform as the joining agent, a more accurate and consistent application of heat is obtained, eliminating the need for detergent cleaning, oxide removal, separate flux application, and washing to remove flux residue.

The brazing machine, designed and built by Selas Corp. of America, consists of two adjacent workstations between which a burner unit on an overhead track is shuttled on a timed basis. Each workstation accommodates a holding fixture that can be adjusted to hold tube and return bend assemblies ranging between 8 and 30 inches in width and from 20 to 60 inches in height. The burner unit is mounted on a motor driven carriage and is comprised of two opposed manifolds, each having 16 gas burners which are fitted with individual stopcocks. The number of burners being used can be varied according to the size of heating element being brazed. A crankscrew and hand lever regulate the flame angle and distance of burners from the workpiece.

In a normal work cycle, an operator inserts the return bends, each fitted with two silver solder preforms, in the flared tube ends of a heating element. After loading the assembly into one of the holding fixtures, the operator presses a pushbutton, causing the burner carriage to shift over the return bends. The operator then moves to the second holding fixture, unloads the brazed element, and loads a new assembly into the fixture. Brazing time varies from 24 to 60 seconds, depending upon assembly size, and is controlled by an adjustable automatic timer. At the end of the preset heating cycle, the carriage automatically shifts the burner unit to the second holding fixture. The holding fixtures are usually set up so that one fixture holds an assembly for brazing return bends to one end, and the other fixture holds it for brazing of the opposite end.



Operator clamps heating element into righthand holding fixture of brazing machine while burner unit is brazing another element in lefthand holding fixture. Close-up view of burner unit is shown in inset. At the end of a preset heating cycle, the burner unit will automatically shift to the element in the righthand fixture. The width and height of the clamping space in the holding fixtures is adjustable to accommodate any of 55 different sizes of heating elements manufactured.

APPLYING OPTOELECTRICAL READOUT

TO PREDETERMINED WEIGHT SCALES

By **WILLIAM HECOX**, Research & Development Engineering, The Exact Weight Scale Co., Columbus, Ohio

A THOUSAND years ago the scale did little more than indicate approximately how much an object weighed. Today, a precision scale can indicate exactly what the weight of an object is, how many cookies are in a box, whether a laboratory rat is sick or healthy, if a piston rod is balanced, the length of a thread wound on a spool, or how much plastic to put in a mold. It can control production processes and product quality in hundreds of industries, and it can count coins and dollar bills at the local bank.

Science has turned the scale into an exacting and versatile tool, and continuing electronic developments are making the scale more versatile every day. Most recently, an optoelectrical device which combines the scale with the electronics technology of the computer industry has been put to work to provide still greater achievements in industrial weighing systems.

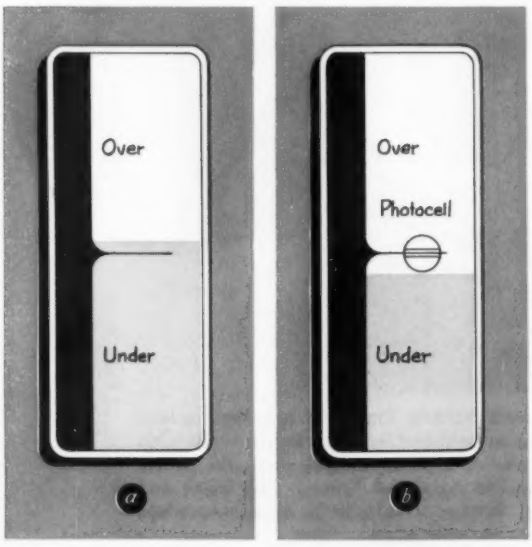


Fig. 1—Predetermined weight scale with a visual readout is shown in (*a*). This system requires that an operator continuously read each weight indication and then actuate gating devices based on visual readout. An improved version with automatic readout is shown in (*b*). In this system a photoelectric cell replaces the operator and actuates a gating device when the shadow image covers the cell, indicating an overweight part.

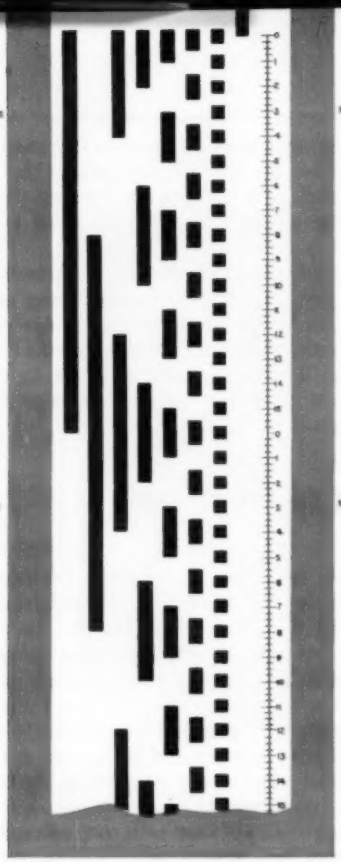
Basic Principles

Optoelectrical binary readout for predetermined weight scales is a new device that provides a means of eliminating such human frailties as inattention, inaccuracy, and inability to remember as well as a means for significantly increasing the speed and versatility of entire weighing systems. With the new readout device as a keystone, automated systems for checkweighing, sorting, counting, indicating, recording, or computing can be realized.

The following terms will be used throughout this article, and they are defined in relation to weight control problems.

Binary means dual, or two-phased. A binary number system, for example, has only two digits (1 and 0, instead of the ten digits (0 through 9) used in a decimal system. Machine language is usually binary in nature because *Off* and *On* signals are the most convenient electrical terms into which information can be translated.

Predetermined weight scales are ones which have been set to measure how each of a series of articles compares



Predetermined weight scales using an optoelectrical binary readout can be applied to solve a multitude of weighing problems varying from manual to automatic operation. The author presents a general description of a binary readout system, explains its principle of operation, and discusses some of its present and potential applications.

Fig. 2—Coded reticle shown is used in a seven photocell weighing system and will originate 128 different code signals. This reticle is designed to readout plus or minus one pound from the predetermined desired weight in increments of ¼ ounce.

with a selected weight standard. In its simplest form, a predetermined weight scale merely shows whether an article is over or under a standard weight. Since its vocabulary is limited to two terms, it gives binary information.

Shadograph is a type of predetermined weight scale that utilizes a projected shadow image of a light as its weight indicator rather than a sweep hand or other type of dial indicator. The sharp shadow-image is projected on a frosted glass screen, making reading much easier and faster and eliminating parallax indicator readings.

Readout is a system or reporting device used by the scale to tell what it senses about the product being weighed. The shadow image is a readout device which in its simplest from uses an elementary binary code, that is, plus and minus, or over and under weight.

As an example of these definitions, *Fig.* 1*a* shows a single binary readout system on a predetermined weight Shadograph scale with a projected shadow image indicating that the article being weighed is overweight, exceeding the standard or predetermined weight. The readout reports its information in vain if no human eye is there to see it, and no human hand is available to act on it. An improved version would be to install an electrical device such as a photoelectric cell, *Fig.* 1*b*, on the zero line of the scale.

When an article is underweight, the cell is illuminated; and when an article is overweight, the cell is in the dark. The useful property of a photoelectric cell is that light renders it highly conductive, and dark makes it resistive. Light induced current is sent through an amplifier to energize a relay, and dark-induced lack of current causes the relay to remain in its unoperated condition. In practice, the cell's work is usually limited to the closing of an electrical relay which in turn allows the application of a heavier current to a work function.

A readout in which a photoelectric cell "sees" a scale dial reading, interprets it, and transmits a signal that a machine can understand and act upon is properly termed an optoelectrical readout system, that is, a system that makes use of both light signals and electrical signals. For example, the most basic form of action a machine takes in automatic checkweighing is to sort the articles being weighed, allowing those within tolerance to pass on and diverting into two other channels the over and underweight items. However, in automated systems a weighing machine is usually required to perform many other inspection tasks such as to measure how much the articles vary from the standard, to count and remember how many items are over and underweight and by how much, to warn if the process gets out of control, and possibly to correct error in process control.

▸ Binary Coding

The machine can more easily do these things now if the binary coded optoelectrical readout is effectively utilized. One photocell can give a machine the ability to communicate with other machines. By adding additional cells, the functions of the machine can be refined and expanded since each additional cell adds two bits of weight information. Since combinations of cells make possible still more measurable weight conditions, the amount of in-

formation increases geometrically. That is, two cells yield four weight increments, three cells yield eight, and so on, in powers of two, until seven cells will give 128 weight increments.

The mechanism by which these signals are generated is simple in principle but rather complex in appearance. A coded reticle like that shown in *Fig.* 2 is projected onto a Shadograph dial where the photocells are mounted. This shadow image is formed by a plate attached to the scale lever which moves up and down as a function of weight. A light source of high intensity projects the sharp shadow image onto the scale dial through an optical system. This system magnifies the lever movement so that, for example, 1/16 inch of actual lever movement can cause 3 or 4 inches of projected shadow travel on the scale dial.

A simplified diagram, *Fig.* 3, traces the general path of the light rays and shows the mounting of a reticle shadow mask. As the scale lever moves up or down, the reticle shadow projected vertically on the Shadograph dial moves also, and the light and shadow pattern projected on the dial causes signals to be generated in the photocells.

Interpreting the Coded Signal

What happens to these signals? To simplify the answer a little, but without otherwise limiting its validity, a basic four photoelectric cell weighing system is shown in the diagram of *Fig.* 4. Each cell is connected through an amplifier to a relay which actuates one or more normally open or normally closed contacts. Three of the cells are used to readout weight changes as the coded shadow image admits or blocks light to the cells, and one cell is used to readout whether the commodity being weighed is on the underweight or overweight side of the desired weight. If all four cells are covered by the shadow code, no current will flow in the circuit, the coded signal will be 0000, and the indicators marked (−) and 0 will illuminate. This indicates that the commodity is of the desired weight. However, if all the cells are uncovered by the code, current will flow in each photocell circuit, the

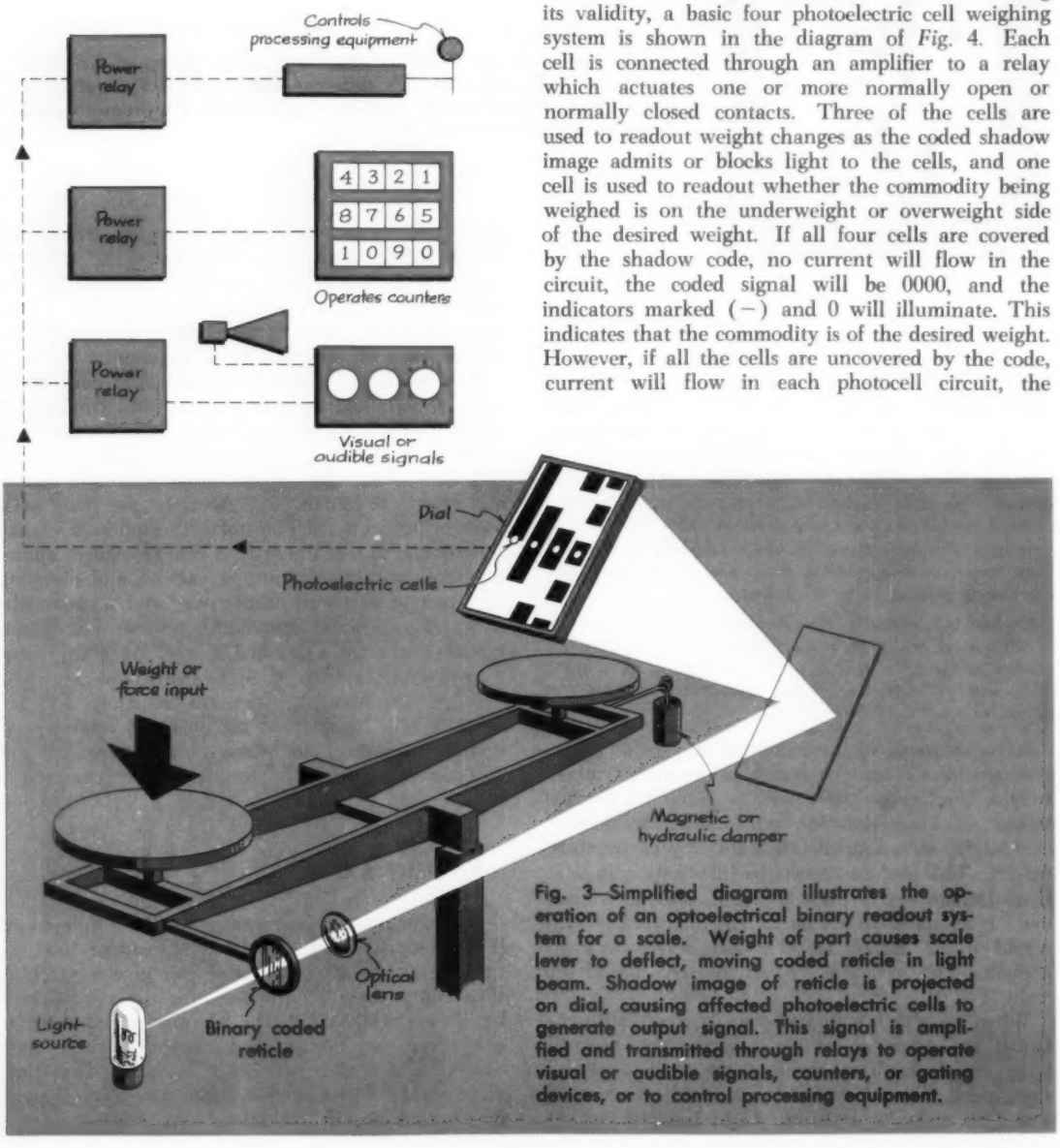


Fig. 3—Simplified diagram illustrates the operation of an optoelectrical binary readout system for a scale. Weight of part causes scale lever to deflect, moving coded reticle in light beam. Shadow image of reticle is projected on dial, causing affected photoelectric cells to generate output signal. This signal is amplified and transmitted through relays to operate visual or audible signals, counters, or gating devices, or to control processing equipment.

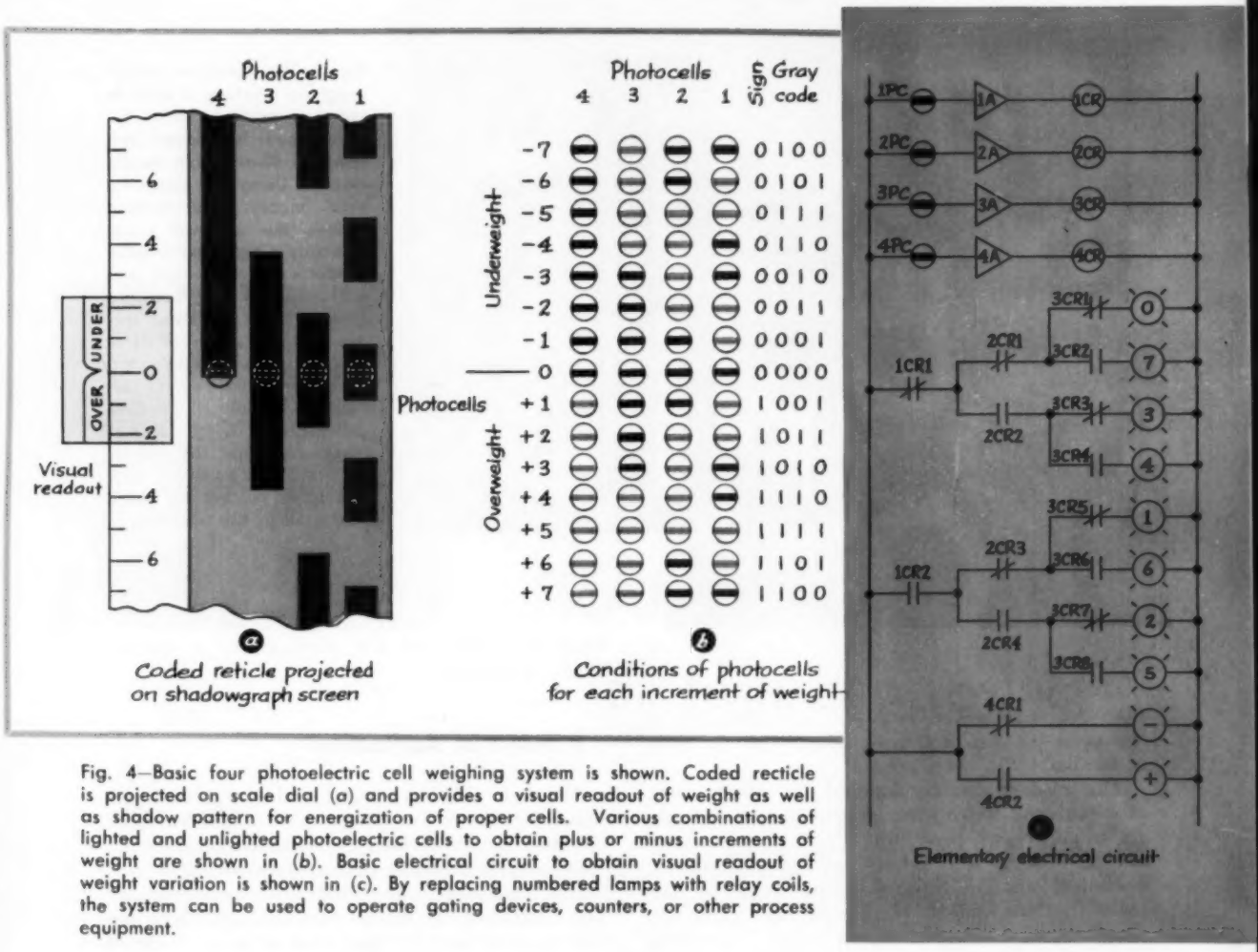


Fig. 4—Basic four photoelectric cell weighing system is shown. Coded recticle is projected on scale dial (*a*) and provides a visual readout of weight as well as shadow pattern for energization of proper cells. Various combinations of lighted and unlighted photoelectric cells to obtain plus or minus increments of weight are shown in (*b*). Basic electrical circuit to obtain visual readout of weight variation is shown in (*c*). By replacing numbered lamps with relay coils, the system can be used to operate gating devices, counters, or other process equipment.

coded signal will be 1111, and the indicators marked (+) and 5 will illuminate. This indicates that the commodity is 5 units overweight.

Other coded signals can be traced through the circuit as simply. For example, a 0010 signal would indicate −3, or 3 units underweight; and a 1011 signal would indicate +2, or 2 units overweight. In place of the lights shown in the electrical circuit, a series of solenoids could be installed so as to operate gating devices for shunting the different classes of commodity into collection bins. Exactly the same type of action occurs in a seven-cell scale, except that the interaction between the relays becomes more complicated.

Once the signal is generated by the readout, it is available for one or more services. In its simplest form and application, the signal can be interpreted to channel the articles into segregated collecting or processing locations. At the same time, it can trigger counting devices to record the number of articles falling into each weight classification, it can operate a recording graph, it can set off warning signals when the process gets out of predetermined control limits, or it can even send corrective control signals back up the line. For example, *Fig.* 5 shows a predetermined weight scale used to sort test products of a nuclear research program into 14 weight classes. This weighing system automatically weighs and classifies the products. It also records the total number of parts checkweighed, the total number overweight, the total number underweight, and the total number of products in each of the 14 weight classifications.

▸ Advantages

Besides its versatility, an optoelectric readout system has other advantages. It is simple and therefore reliable. The binary coded reticle is designed so that only one photocell at a time changes from light to dark as the reticle moves (known as a Gray code), and consequently only one new cell at any one instant is asked to make a decision as to whether it is light or dark. Further, a cell's change from light to dark always involves two immediately adjacent units on the readout dial, such as 2 and 3—never widely separated units, like 2 and 7. In addition, the coded readout is directly correlated with a visual dial indication, both being projected

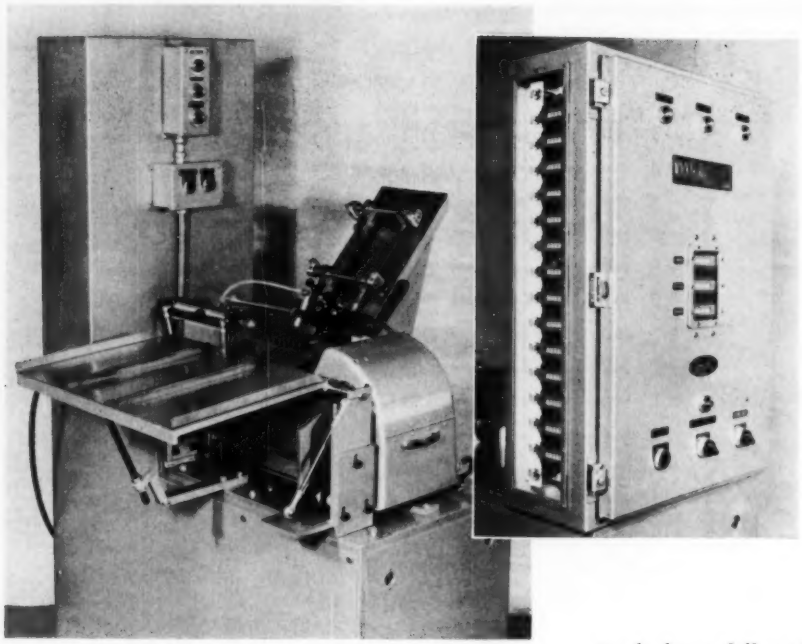


Fig. 5—This automatic checkweighing machine is used to sort test products of a nuclear research program into fourteen 40-milligram weight classes. Using an optoelectrical binary code readout system, the unit will automatically weigh and classify products into 14 classes and will maintain an accurate running count and visual record of the number of items in each weigh classification by means of the counter unit (inset). In addition, the unit will register the number of items overweight, the number of items underweight, and the total number of items processed by the machine.

from the same source, both read out effectively at the same position, and both immune to the error of parallax.

The readout can be designed for either metric or avoirdupois weights, or for fractions or decimals. Its amplifier can be a fully transistorized printed circuit, making it extremely reliable and cool in operation; and an integral voltage regulator can make it independent of line-voltage variations. Checkweighing, classifying, recording, controlling, and sorting of products, from a few grams up to 100 pounds, can be accomplished. Even with heavy products or with extremely small weight tolerances, production speeds can be obtained.

An automatic transfer mechanism can be provided to place a commodity on the scale and remove it with a minimum of impact and with no direct connection with the scale lever system. Thus, highly sensitive scales can be used. They can be fast-reading, even-balance (1:1 ratio) industrial scales which are generally more accurate and faster than catch-weight scales, because they do not have as much lever fall and dial displacement as do the catch-weight scales.

▶ Industrial Applications

Although checkweighing has been part of the industrial scene for years, the automatic optoelectrical binary readout for predetermined weight scales creates extensive new applications. It is currently being used in many industries for production-line inspection of metal assemblies to check for missing parts and for inspection of open or closed packages for correct contents. It is used for loading correct contents into packages and bottles, for classifying of products and packages by weight, for adding exacting amounts of high concentrate chemicals into processing streams, and for controlling the amount of plastic placed in injection molding machines. Potential applications are limited only by the imagination of the production engineers. Since scales and their associated indication and control systems are used constantly, we can confidently anticipate a continuing stream of new applications and new developments.

can we help?

It has been pointedly mentioned at various times that in engineering automated systems new as well as old techniques and devices may prove extremely useful. Practical results require the investigation of all available equipment that can contribute to the effective development of suitable automatic lines. Information on such equipment is presented in various departments of the magazine each month as useful data become available. To aid in obtaining detailed data for further evaluation a post card is included on page 19. Take advantage of this service. The Editors will be glad to help in this or any other way.

Fig. 1—Automated equipment for production of PNP germanium transistors includes three automatic boat loaders, an alloying furnace, and testing and sorting equipment. The automatic boat loader feeds multicavity boats from a magazine, fills the cavities with transistor parts, and places covers on the boats preparatory to alloying of parts in furnace.

ASSEMBLING TRANSISTOR PARTS

FOR FURNACE ALLOYING

AS PART of continuing program for achieving highest product quality at lowest cost, the Semiconductor Div., Raytheon Co., is converting to automated production of its medium frequency PNP germanium transistors. Besides savings in direct labor, a great improvement in reliability has been gained over the manual methods previously employed. In addition, the equipment is readily adaptable to production of other transistor lines.

Formerly, each alloy junction transistor was assembled by manually placing an emitter dot, a base tab, a germanium crystal, and a collector dot into the cavity of a carbon "boat." A cover and weights, or plungers, were added as required, and the pieces were then fired in a furnace to produce an alloyed transistor subassembly. Although handling aids were used in some cases to facilitate part of the work, the over-all procedure required a great deal of patience and skill on the part of operators. With the new setup, operators are required only to monitor the performance of automatic equipment and check the supplies of parts.

An automatic boat loader has been developed to perform these operations automatically. This machine, *Fig.* 1, consists principally of a linear indexing mechanism which moves a line of multicavity boats through part and cover feeding stations. A mechanical feeder at each station positions a transistor part into a boat cavity, or places a cover on a boat. The machine produces 2500 transistor subassemblies per hour.

Each boat, *Fig.* 2, contains a single row of cavities that are uniformly spaced along its main axis. The

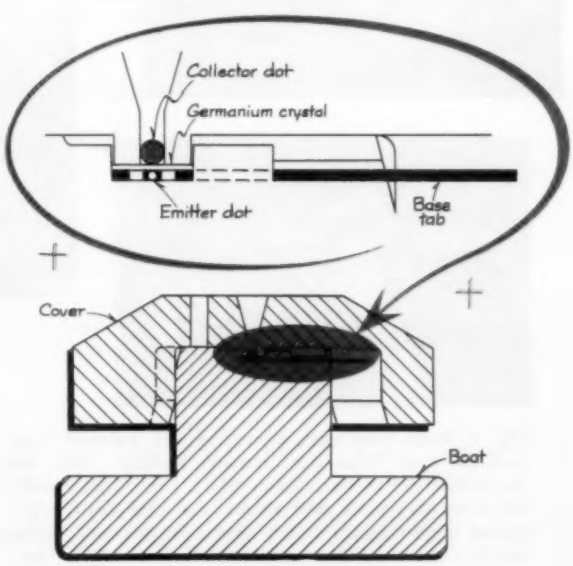


Fig. 2—Cross-sectional view of multicavity carbon boat shows relative positions of transistor parts loaded in one cavity. Base tab projects beyond side of boat to facilitate grasping alloyed transistor assembly for further automatic processing. Cover protects parts and holds them in position during alloying in furnace.

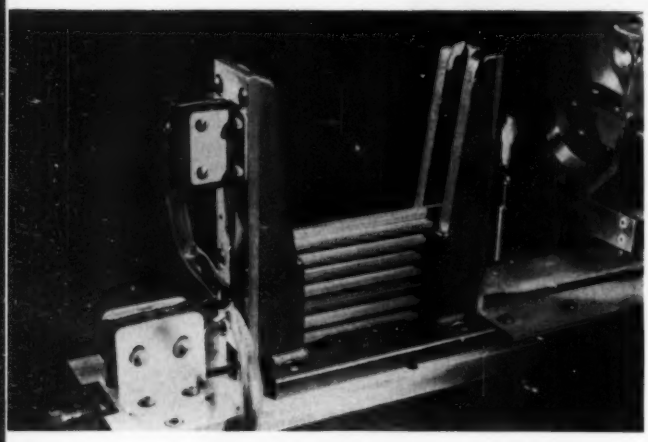


Fig. 3—Close-up illustrates boat feeding mechanism at input end of automatic boat loader. Boats, in magazine, are escaped sequentially from bottom of stack and advanced to right by pin on transfer bar. Other pins on transfer bar index boats through feeding stations where transistor parts are inserted in cavities and covers are placed on boats.

base tabs of the transistor subassemblies extend beyond one side of each boat, providing a means of grasping the alloyed subassemblies for further automatic processing. The cover on each boat helps to position the transistor parts and protects them as well as the base tab extensions.

System Operation

As the loading operation begins, empty boats, stacked in a magazine at one end of the loader, *Fig.* 3, are fed from the magazine and along the machine by a series of pins attached to a transfer bar. Each pin pushes a boat along a track as the transfer bar is indexed in single-cavity increments. As each cavity is positioned at a part feeding station, a transistor part is fed into the cavity.

The part feeding stations are spaced apart at multiples of a boat length and feed corresponding cavities simultaneously. Thus, each boat at a part feeding station is completely filled at the same time as the boats at every other part feeding station. While the last cavity of each boat is being filled, the transfer bar rotates 90 degrees to swing the transfer pins down and disengage the pins from the boats. The transfer bar then retracts and counter-rotates, bringing the pins into position to feed in an empty boat, advance the boats in process, and eject a filled boat and cover. The arrangement is such that the same pin positions the boats at a given station. This ensures the greatest accuracy in parts positioning.

The transfer bar is indexed by means of an arm operating on an eccentric. The arm is engaged in

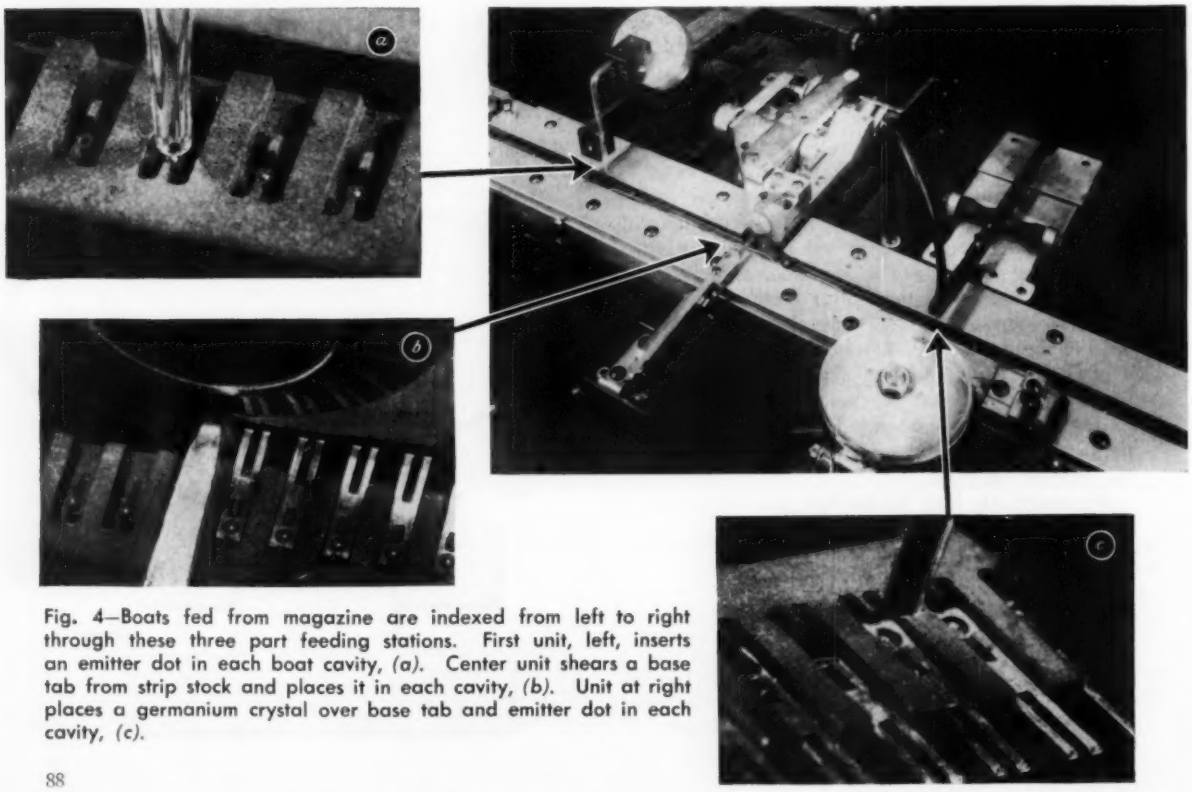


Fig. 4—Boats fed from magazine are indexed from left to right through these three part feeding stations. First unit, left, inserts an emitter dot in each boat cavity, *(a)*. Center unit shears a base tab from strip stock and places it in each cavity, *(b)*. Unit at right places a germanium crystal over base tab and emitter dot in each cavity, *(c)*.

a rack on the bottom of the bar. Engagement occurs for one-half of every other revolution of the driving eccentric to provide advancement of the transfer bar for one-fourth of the machine cycle. Indexing motion is a modified harmonic type.

▶ Feeding Stations

The emitter dot (a 0.009-inch diameter indium sphere) is the first transistor part fed into each cavity, *Fig.* 4. Due to the small size of the part, and the softness of indium metal, the spheres tend to adhere to most materials, making it difficult to use conventional escapement mechanisms for automatic handling.

The emitter dot feeder developed for the automatic boat loader consists of a chamber into which a single sphere is isolated by a vacuum system. The sphere is then pneumatically directed into a boat cavity through a glass tube, *Fig.* 4*a*.

Base tabs are fed into each boat from a continuous coil of prestamped, tin-clad nickel ribbon. The stamping of the ribbon is so arranged that a simple shearing operation provides a complete base tab. The ribbon is fed, tinned side up, over the boat cavity by means of a hitch-feed mechanism that engages a prestamped reference surface for each tab. This ensures accurate positioning without cumulative error. A finger, operating from the opposite side of the track, guides and presses the ribbon into the boat cavity, *Fig.* 4*b*. At the same time, the ribbon is sheared to form the tab. The boat cavity is designed to position the base tab so that a hole in the tab contains the emitter dot in the hole center.

A germanium crystal (0.045-inch square by 0.0025-inch thick) is next placed over the base tab and emitter sphere in each boat cavity. A rotating dish, inclined at about 30 degrees from horizontal, contains square cavities located in a circular array. Each cavity is wide enough to contain and orient a crystal lying flat and is deep enough to hold several crystals. The dish, partly filled with crystals, is indexed about its center. As each cavity passes beneath the load of crystals, it receives several crystals and carries them to the high point of its path. A vacuum capillary pickup, mounted on an arm, removes the top crystal from the cavity and carries it to a boat where it is deposited, *Fig.* 4*c*.

The boat next passes beneath a magazine which stores boat covers, *Fig.* 5. A mechanical gate retains the covers in the magazine. Each of two vertical slides, one at each end of the magazine, carries a pair of metal fingers. When the slides are in an elevated position, the fingers grasp the bottom cover, and the gate is opened. The fingers are lowered by the slide, carrying the cover downward to a position where the gate closes on the second from bottom cover. The fingers then carry the bottom cover onto the boat.

In order to ensure that the cover is securely attached to the boat, and located laterally against the reference side of the boat, the cover is slotted to provide a spring-loaded fit with the boat. Considerable force is required to seat the cover in place on the boat, so a set of spring-loaded fingers presses the cover downward while it is being guided by the slide fingers.

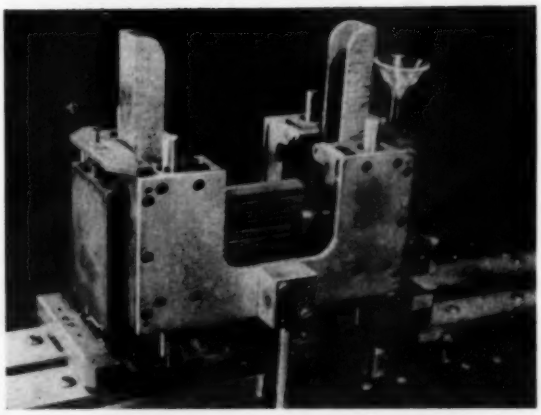


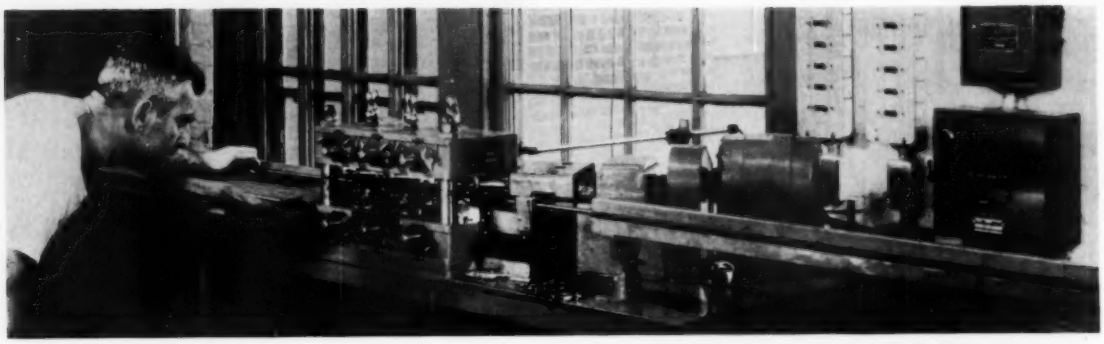
Fig. 5—Carbon boat covers, stacked in magazine, are placed on top of boats containing transistor parts. Covers are guided by vertical slides and escape downward so that spring-loaded fingers can force bottom cover in stack onto a boat in feeding position. Glass funnel at right is associated with part feeding station where a collector dot is fed to each boat cavity through a hole in the cover. Filled boats with covers are discharged from boat loader for movement to alloying furnace.

Indium collector dots are fed on top of the crystals by a mechanism that is similar to the device used to feed emitter dots. In the case of collector dots, however, tapered holes in the boat covers are used to direct and locate the collector dots over the crystals. Since additional weights or plungers are not required in the production of this transistor, feeding of the collector dots completes the loading of the boats. After ejection from the loading machine, filled boats with covers are passed through a furnace for alloying of the transistor parts.

▶ Integrated Lines

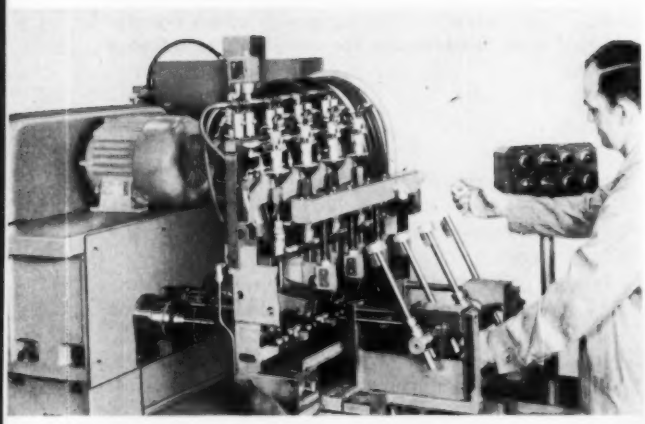
At present, Raytheon has built and is operating three automatic boat loaders. Other units are under construction. This development represents the first stage in the establishment of completely automatic transistor production lines. Some of the automatic equipment for succeeding operations of the process has been built and is operating. Other units are in the design and development phase.

Features of the automatic production lines will provide for automatic testing, sorting, and re-processing of individual transistor units. Carriers and boats are designed so that the units may be automatically removed and replaced for individual processing, or entire carrier loads may be handled for batch processing. Multicavity boats and carriers allow close cavity spacing, thereby permitting rapid machine transfer from cavity to cavity.



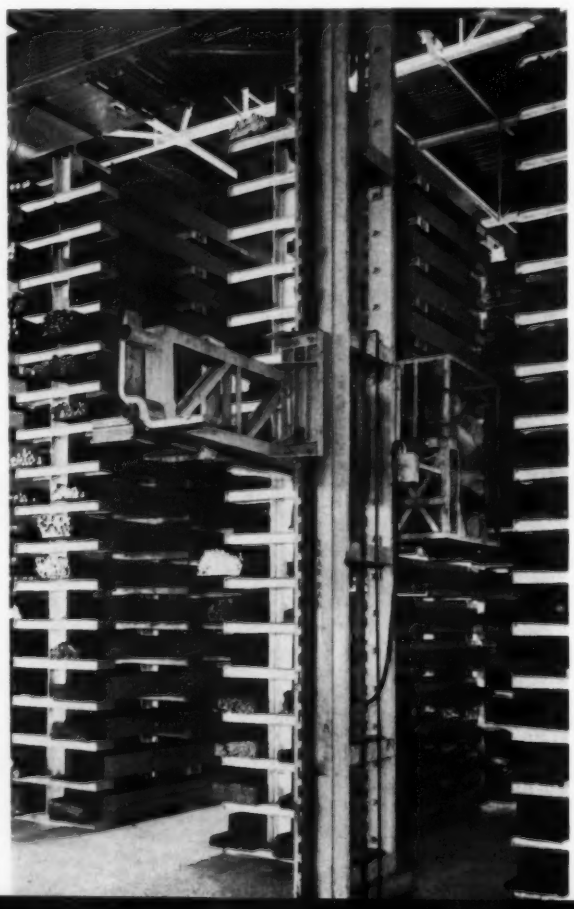
Straightening Tubing for Jewelry

JEWELRY manufacture used to be a strictly manual process. Now jewelry manufacturers are using more and more automatic machinery to make parts from tubing which must be straight and round within narrow limits. Leach & Garner Co. supplies such tubing to manufacturers of jewelry, electron tube parts, aircraft tubing, and similar components. Using a rotary straightener built by Mackintosh-Hemphill Div., E. W. Bliss Co., they straighten and round gold, platinum, palladium, silver, copper, and other nonferrous tubing between 1/8 and 7/16 inch in diameter. Lengths of tubing must be uniformly accurate, without bent ends, when tube materials of such high intrinsic value are being processed.



Boring Small Bearings

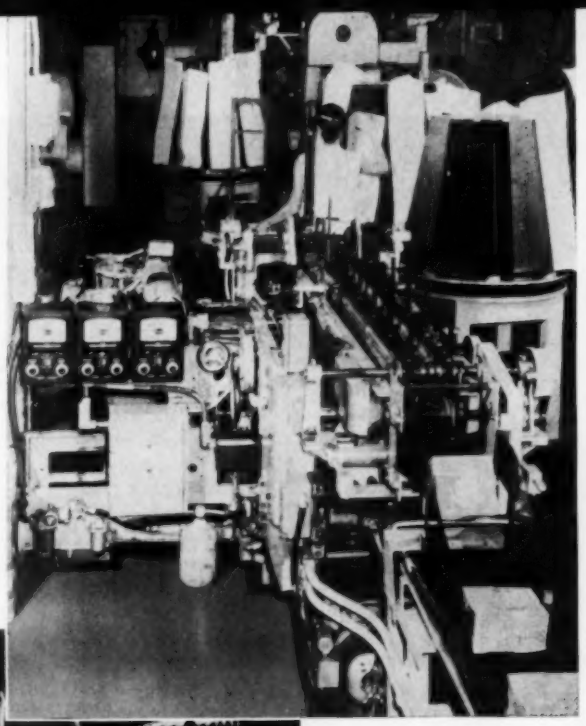
ALUMINUM die-cast valve rocker shaft bearings are rough and finish bored four at a time in a cycle requiring only 16 seconds. Parts are manually loaded and radially located on a ram type feeder. The final movement of the loading mechanism initiates the automatic cycle, and automatic toggle clamps swing downward while a set of overhead pneumatic hammers tap the parts to ensure accurate seating on location pads. After both rough and finish boring is performed, the clamps are released, and air pressure forces the workpieces onto a conveyor. The machine is a standard single-end precision boring unit built by Ex-Cell-O Corp.



Storing Steel

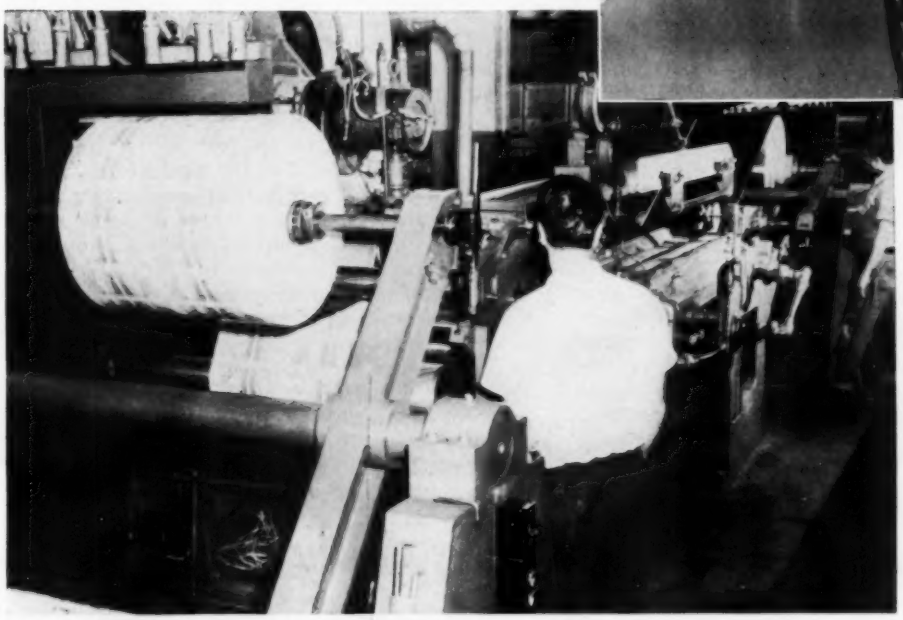
STORAGE space for 1350 different sizes of steel bars and tubes is provided by this rack system installed at the Cleveland Service Center of the Warehouse Div., Jones & Laughlin Steel Corp. The rack system is over 22 feet high and covers a floor area of only 60 by 160 feet. Each rack unit has 17 shelves which can hold either 12 to 14 foot lengths of steel in 11-foot pans or 20 to 24 foot lengths in 16-foot pans. Up to 3 tons of material can be supported in each pan. The rack operator can select and deliver a pan of steel from the system in less than 3 minutes by means of the overhead crane system furnished by Chicago Tramrail Corp. The pan is delivered to a table where end supports hold the load of steel as the pan drops down. After selected pieces are removed from the load, the crane operator lifts the pan under the steel and moves the pan back to its proper place in the rack system.

in action



Packaging Napkins

PAPER napkins are overwrapped in polyethylene automatically by this equipment at Scott Paper Co. An operator transfers pre-counted stacks of napkins from racks to the infeed station of a wrapping machine specially engineered for the job by Battle Creek Packaging Machines Inc. The machine cuts off printed polyethylene, forms it around the package, and heat seals it at high speed.



Monitoring Plastic Extrusion

FOOD envelopes for dehydrated soft drinks, instant coffees, soups, and frozen foods can be made from an aluminum-foil-covered paper which is coated with polyethylene in this 42-inch-wide plastic coating mill. If narrow temperature tolerances were not maintained, the plastic resin would be degraded and gage of the extruded coating would vary. Reynolds Metals Co. uses a multipoint recorder manufactured by Weston Instruments Div., Daystrom Inc., to record temperature data from 11 thermocouples installed at key points on the extrusion section. Rolling speed of the mill in feet per minute and turns of the plastic-extruder screw in revolutions per minute are also recorded.

Dispatching Newspaper Bundles

HANDLING of 300,000 newspapers daily and over 330,000 on Sundays is accomplished by a programmed dispatching system at the Washington *Star*. Six conveyors deposit wire-tied bundles on a sectionalized main dispatching conveyor. The operator seated at the console programs the system which controls 24 conveyor sections with 18 deflectors for switching bundles from the conveyor to any of 18 chutes to the loading dock. The system was built by T.W. & C.B. Sheridan Co. using modular control enclosures manufactured by Emcor Ingersoll Products Div., Borg-Warner Corp.

SPECIAL TABLE SIMPLIFIES TURRET DRILL SETUP

WHEN a considerable portion of a company's business consists of custom fabrication to customer requirements, short production runs and constant design changes can be major problems. Such is the case at National Vulcanized Fibre Co. where, in addition to supplying basic fiber and plastic materials, a large part of the company's business is the supplying of precision fabricated parts for electrical, electronic, and military applications. Because of the specialized nature of the equipment in which the parts are used, production runs of a part may vary from one part to 300 parts.

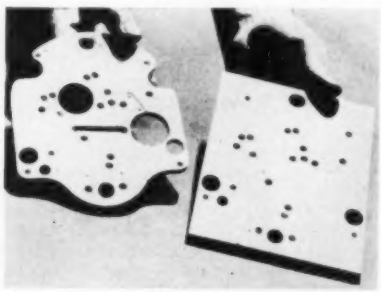
Recognizing the value of numerical control for small lot production, the company has installed a six-spindle numerically controlled turret drill manufactured by Burg Tool Mfg. Co. Inc. and equipped with a General Electric Co. tape control system. The two-axis system positions the work table and operates the turret in accordance with a program punched in fiber tape.

To increase the flexibility of the system, National Vulcanized Fibre designed and built a special work table to replace the standard table of the turret drill. The special table is laid out with 322 positioning holes drilled on 1½-inch centers which progress from a common zero point along the *X* and *Y*-axes. This layout permits a part to be accurately located in relation to the zero point in an infinite number of positions with simple stop blocks and pins and reduces the need for special fixtures.

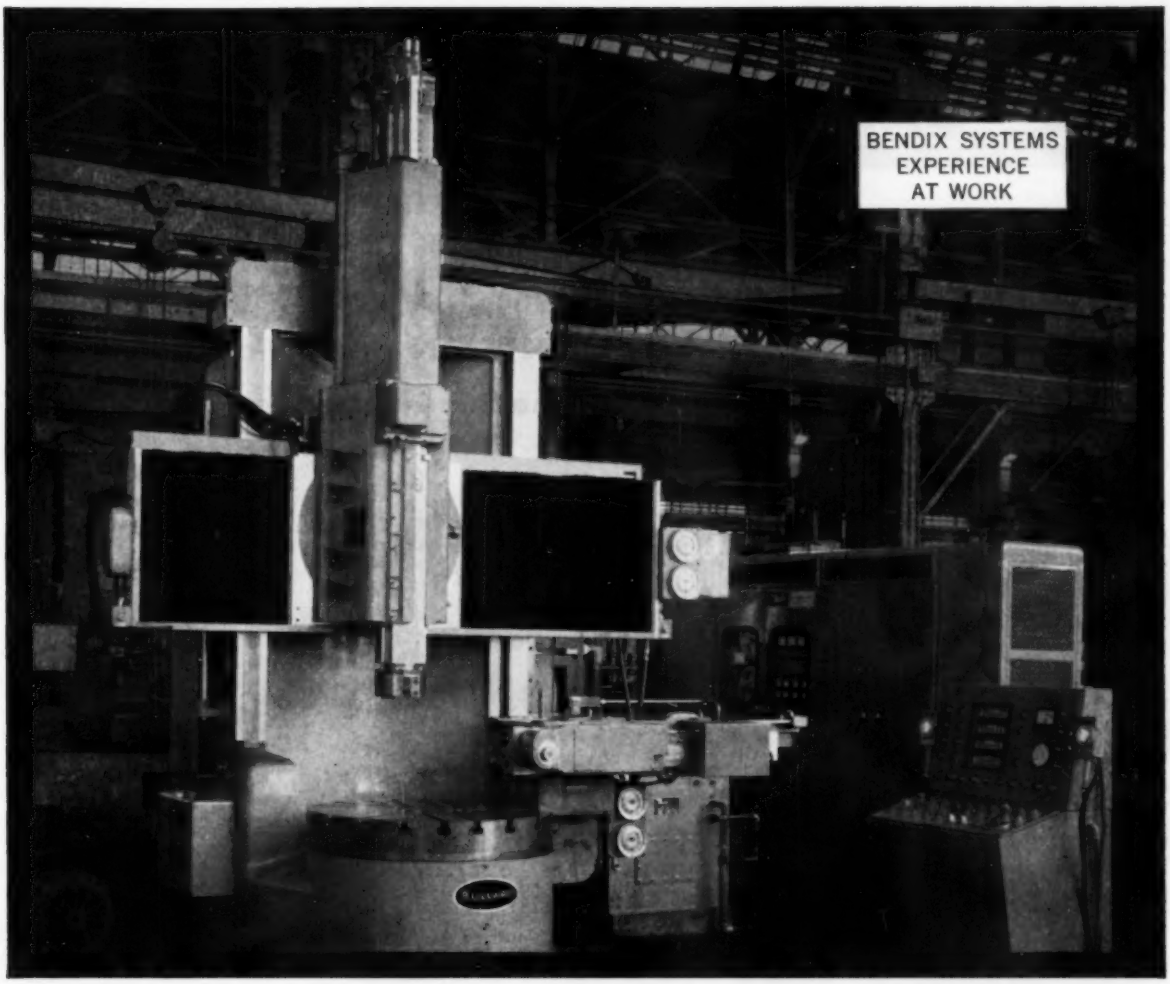
The table can be traversed to provide a 15-inch by 26-inch working area for the tools. Since the special table is larger than these dimensions, the entire working area can be used productively. Air clamps or other holding fixtures can be positioned outside the working area if necessary. When small parts are being processed, it is possible to set up two work stations within the working area. While one part is being drilled under tape control, an operator can unload the previously finished part and load a new part. In this case, the tape is programmed to automatically shift the table to the new part when drilling is completed on the part being processed. Both work stations are controlled from a single, continuous tape loop.

In operation, the machine operator is furnished a program sheet and a control tape. The program sheet lists the correct drills for each spindle and indicates the feed and speed of each. A positioning diagram on the sheet shows the operator where to insert pins and stop blocks in the machine table. After the tools and table have been set up, the operator inserts the tape in a tape reader, and the machine is ready to operate. A typical part handled by the machine is a silicone-glass laminate bulkhead for an aircraft computer with 36 holes drilled from each side. Formerly, it required the use of a drill jig, costing $160, which took a week to design and build. The operation is now done on the turret drill under numerical control, and no drill jigs are required.

The tape used in the tape reader is one of National Vulcanized Fibre's own products. It is a special grade of vulcanized fiber tape with high tensile and bending strength. The tape is made primarily for control applications where toughness is required due to rough handling and repeated use.



Operator is shown setting up the tape controlled turret drill for drilling silicone-glass laminate parts such as are shown above. Special work table has 322 holes on 1½-inch centers to simplify positioning of stop blocks and air clamps. In the setup shown, the table holds two work stations. While the machine automatically drills one part, a finished part in the other station can be unloaded and replaced with a new part to be drilled.



BENDIX SYSTEM ENGINEERING PROVIDES OPTIMUM NUMERICAL CONTROL FOR TURRET LATHE

Shown above is a Bullard four-axis vertical turret lathe equipped with Bendix DynaPath-14 contouring control unit. In this application, the selection of tools and spindle speeds is programmed, as is the motion of both slides.

Bendix application engineers, with accumulated experience in mechanical and hydraulic analysis of machine tools, worked closely with Bullard to produce this wedding of machine tool and numerical controls. And Bendix systems experience gained in working on other contour turning applications (with such companies as Ex-Cell-O, Heald, and Giddings & Lewis) assures the user correct application of control unit to machine tool.

In addition to contour turning applications, Bendix engineers numerical control systems for milling, grinding, drilling and jig boring machines. We have developed and applied controls to 2-, 3-, 4-, and 5-axis systems, both continuous path and point-to-point. These controls are being used daily in plants across the country to increase machine tool efficiency, reduce lead times, and make parts of consistently high accuracy.

Bendix SYSTEMS EXPERIENCE can provide the key to your machine tool problems. The right Bendix numerical control unit can be the profit-maker you've been looking for. Start putting Bendix application engineering experience to work for *you*—write today for a copy of our catalog number 308.

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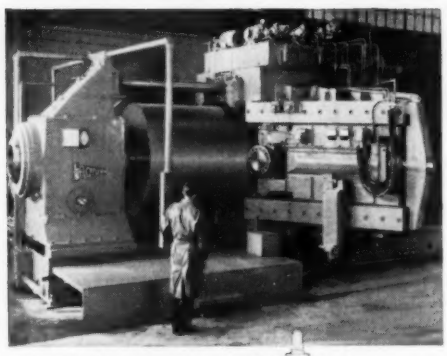
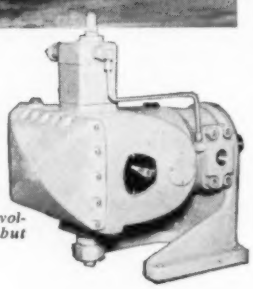
How **LODGE & SHIPLEY** get smooth, variable feed control with **DENISON** hydraulic power on new machine designed for...

SHEAR FORM





SHEAR FORMING MISSILE SECTIONS *up to 70" in diameter, 140" long is done on new 190,000 lb.* FLOTURN® *machine made by The Lodge & Shipley Co., Cincinnati. Denison Series 800 Variable Volume Piston Pump (shown at right with pressure compensator control) varies output volume to maintain fixed, but adjustable, pressure.*

HERE'S ONE of the largest horizontal shear forming machines ever built. This 150 hp giant was developed by Lodge & Shipley to handle the tough metal forming job of flowing ultrahigh-strength forged steel rings into rocket cases for the Minuteman ICBM. Their new FLOTURN® machine does the work faster than the previous method . . . saves materials, too.

Lodge & Shipley designers faced this key problem: how to provide variable feed control of all carriage movements without use of gears or belts. High efficiency and low heat conditions were additional drive system requirements.

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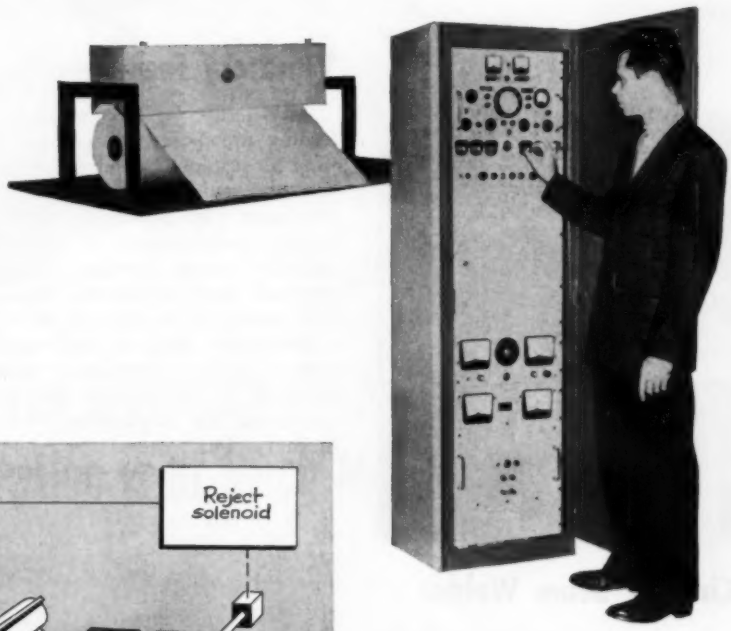
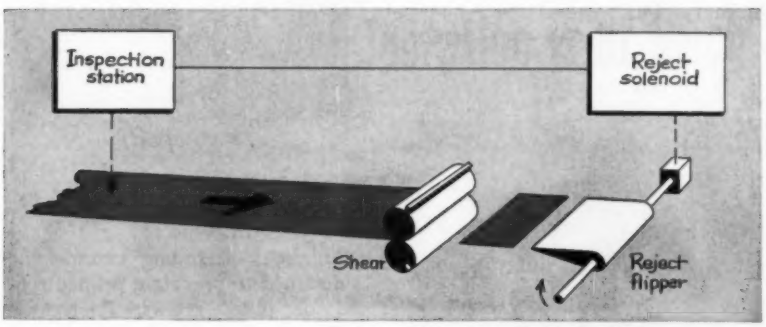
AUTOMATION

new equipment

Machines and plant equipment for more automatic operations.
For detailed information and literature, use card page 35.

System is designed to inspect paper by monitoring the light reflected from its surface. The inspection head proper contains a specially designed illumination and viewing system, which, in combination with a series of photoelectric elements converts the visual quality of a paper surface into electrical information. A separate rack contains the signal collection and classifying circuitry which processes the large volume of information being collected from the surface of the sheet as it travels at high speed past the inspection head. Transistorized plug-in modules, employed in this system, permit ready expansion of the system to fit any size web.





In a typical inspection installation, match-head size flaws in paper stock moving at 1000 fpm are detected, classified, and stored at the inspection station. When faulty paper is cut by the shear, a memory device causes the reject solenoid to actuate the reject flipper, gating the faulty sheet into a seconds piler. The system also detects smudges, creases, and wrinkles which may impair subsequent printing, as well as defects in the gloss of the paper stock.

Paper Flaw Detection and Classifying System

ELECTRONIC paper flaw detector, developed by the **Industrial & Automation Div., Radio Corp. of America,** Front and Cooper Streets, Camden 2, N. J., is especially designed for use in the paper industry to provide effective quality control through the use of electronic inspection. Its function is to inspect paper by monitoring the light reflected from its surface. Suggested applications for the installation of this system are: On the output of a paper machine to sound an alarm in event of excessive flaw content to prevent producing large quantities of inferior paper; use on rewinders to provide over-all quality classification for each roll; and use on sheet handling equipment to sort sheets of paper in accordance with their flaw content. Designed to scan paper moving at 1000 feet per minute, this system can detect dark spots or holes $\frac{1}{16}$ of an inch in diameter. It detects smudges, creases, or wrinkles which may impair subsequent printing, as well as defects in the paper stock's gloss. The inspecting head can be arranged to accommodate various machine widths. On wide machines it is possible to electrically separate the complete width into segments for independent quality grading.

In a typical operation, this system is used in conjunction with sheet cutting and handling machinery manufactured by Maxon Automatic Machinery Co. Rolls of paper in varying widths come from the paper-making machines and are

placed on rewinders. From the rewinder, the paper is passed through a slitter, then is fed through the detector and classifier. It is then fed into the single roll sheeter and double lay-boy piler. The electronic detecting equipment inspects and monitors the sheets for flaws, feeding the information through the signal collection and classification circuitry in the control panel. The output signals from this rack are transferred to a signal storage memory device. This determines whether the quality of paper is a first, second, or reject.

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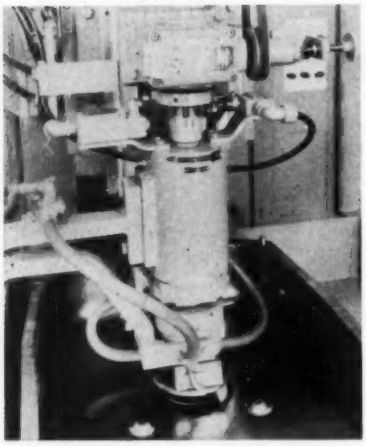

Circular Seam Welder

Rotating head welder is ideally suited for handling ring welding jobs from ¾ to 6 inches in diameter. Typical uses include welding filler necks and large drains to tanks, welding heat-exchange tubes to header plates, and welding flanges to large-diameter thin walled tubing. In this seam welder the electrode is a circular cup-type die running on an adjustable eccentric drive. The unit is equipped with an automatic 10-point heat compensating regulator and an automatic time out and wheel return with speed adjustable to 6 rpm. A ¼ hp motor drives the head through a gear reducer with cam initiation of weld timer. Head illustrated is mounted on a AVA-2 press type welder with 200 kva transformer and a 7-inch adjustable stroke cylinder. **Precision Welder and Flexopress Corp.**, 3520 Ibsen Ave., Cincinnati 9, Ohio.

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Vibratory Feeder

Parts feeder for oriented position feeding incorporates improvements, such as instantaneous rate of flow controls, and is designed to give maximum part delivery with long lasting performance. A selective variable control provides accurate nominal flow regulation. Because this control is electric, it provides a continuous range of feed regulations to make it correspond to the capacity of automatic assembly equipment. **Elk Engineering Works**, St. Marys, Pa.

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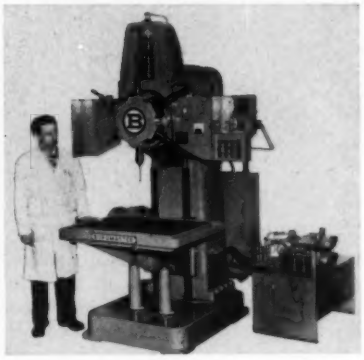

Turret Drill

Heavy-duty hydraulic six-spindle turret drilling machine is used for operations such as precision drilling, reaming, tapping, boring, counterboring, spotfacing, port cutting, etc. without guide bushings. Driven by a 7½ hp motor, unit has a 1¼-inch capacity in steel and a speed range of 90-3000 rpm; throat depth 17 3/16 inches, and turret travel 10 inches. It has constant positive hydraulic feed set by dial; direct reading electrical feed indicator; and automatic temperature and pressure compensation of hydraulic feed to insure accurate feed rates under all conditions. Its turret clamp employs a V type automatic clamping ring for increased turret rigidity during heavy machining operations. Model 25 AH has a four-speed motor drive providing 24 speeds in 3 ranges of 8 speeds per spindle. Accuracy of turret index, one spindle to another, is within 0.0005 inch. The turret power indexes, including skip indexing past idle spindles. **Burg Tool Mfg. Co.**, 15001 S. Figueroa St., Gardena, Calif.

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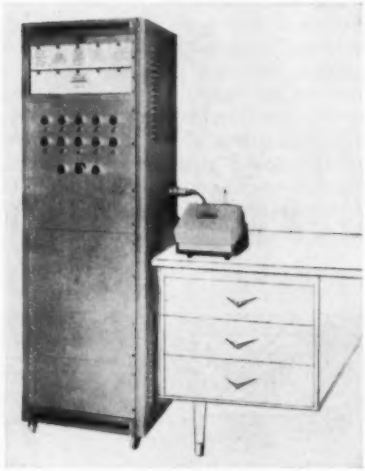

Recording Annunciator

Automatic recording annunciator is designed to provide a printed record of plant events. It records (prints) selected *off-normal* and *return-to-normal* conditions at the command of a variety of simple contact devices such as pressure or temperature switches, limit switches, overspeed switches, and overload relays. Printed record includes the specific condition, and the month, day, hour, minute and second of occurrence. This annunciator has been developed to pinpoint operating deficiencies; relieve operating personnel of logging duties; eliminate chance of human error; and to provide continuous 24-hour vigilance. It is available in three basic models providing scanning of 32, 64, and 1000 conditions. **Scam Instrument Corp.**, 3101 N. Lowell Ave., Chicago 41, Ill.

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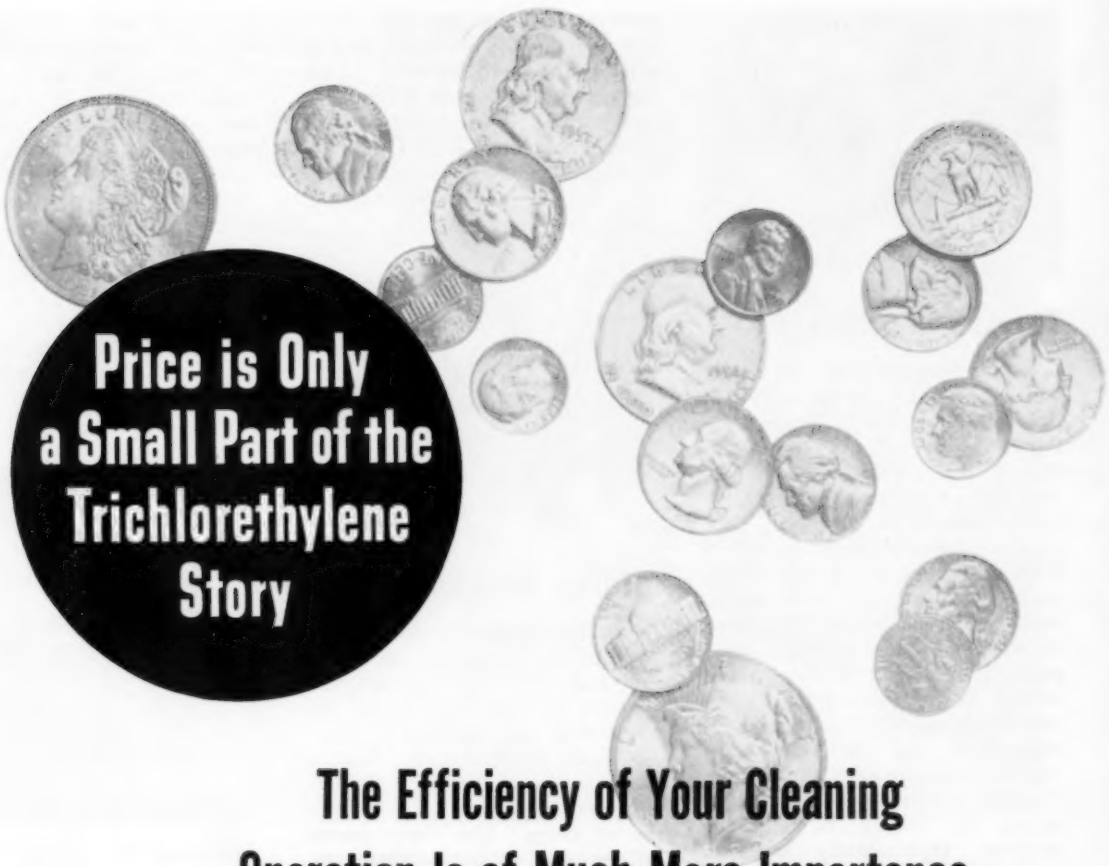

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World's Largest Exclusive Producer of Cleaning Chemicals and Equipment

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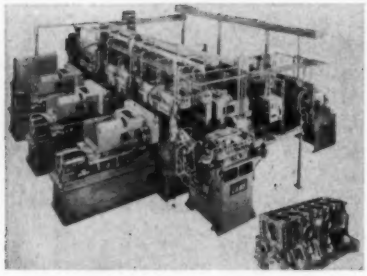

Transfer Machine

Unit is designed to perform rough, semifinish, and finish operations in front and rear faces of die cast aluminum cylinder blocks. It was arranged for quick conversion to cast iron block production by providing change gears in the workheads. Conversion takes only a few minutes per head and does not require disassembly of the head. This twelve-station transfer machine is composed of standard building block components with tools for two stations carried on a single slide. This arrangement reduces the number of wing units and slides and holds over-all machine size to a minimum. A walking beam type transfer bar moves the blocks through the machine. Hydraulically actuated, wedge locking overhead clamps hold the blocks securely on locating pins and hardened pads. **F. Jos. Lamb Co.**, 5663 E. Nine Mile Rd., Detroit, Mich.

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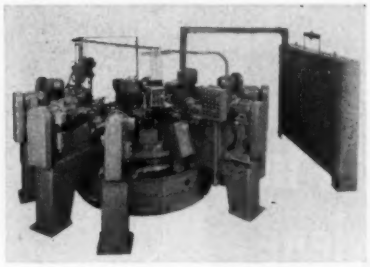
Bender and Cutter

Complete cycle time of this rotary type hydraulic bending machine is approximately 5 seconds. Up to 1800 pieces per hour (2 bend arrangement) and 900 pieces per hour (single bend arrangement) can be processed. Machine specifications: Maximum capacity 1⅝ inch OD pipe or tube (1⅛ OD tubes, two at a time)—maximum radius adjustment, 4 inches—mandrel clearance, 20 feet. Standard cutting unit is a 14-inch abrasive wheel. For cutting nonferrous materials a steel carbide tipped blade is used. **Wallace Supplies Mfg. Co.**, 1304 Diversey Parkway, Chicago 14, Ill.

Circle 407 on Page 35



Drilling Machine

Machine is designed for drilling and milling automotive connecting rods and caps. In each rod and cap two oil holes are drilled and countersunk and one notch is milled. The holes are first spot drilled to form a countersink and three drill passes are taken for the drilling of the oil holes. This eleven-station drilling and milling machine employs eight R-J self-contained hydraulic quill units each with a two-spindle head for the drilling operations. For the milling operation, a special mill head is provided to mill the notch in each rod and cap. The mill head is mounted on an eight-inch hydraulic slide. Cycle time of the machine is 10.5 seconds. **Rehnberg-Jacobson Mfg. Co.**, 2135 Kishwaukee St., Rockford, Ill.

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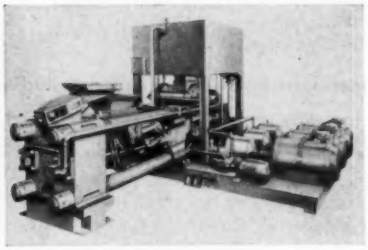

Scrap Briquetting Press

Automatic briquetting press is powered by three 125-hp electric motors, and is capable of converting up to 9 tons of machine tool scrap per hour into cylindrical briquettes having a density of 80 per cent. Individual briquettes weigh from 30 to 40 lbs each, and they are classifed as high grade scrap. Briquettes produced on Model AL-1000 are suitable for direct charging into furnace or cupola. Scraps currently being briquetted include such metals as cast iron, steel, uranium, zirconium, aluminum, and bronze. **Milwaukee Foundry Equipment Div., SPO Inc.**, 6306 W. Bruce St., Milwaukee 46, Wis.

Circle 409 on Page 35

Engineering Computer

Designed for scientific use, this engineering computer can now be applied to solving technical business problems as well. It can be used in support of larger data processing system installations, and is particularly adaptable to problems such as petroleum blend evaluation, highway cut-and-fill, bridge design, and public utility power requirements analysis. Chief among the optional features which extend the capabilities of this compact, transistorized machine are a tripled memory capacity plus punched card input and output. A basic Model 1620 has 20,000 positions of magnetic core storage and paper tape and electric typewriter input and output. An expanded model can have 40,000 or 60,000 positions of magnetic core memory. Other features include both indirect addressing and direct division. The computer is able to make more than 100,000 calculations a minute. Its card read punch provides an input rate of 250 cards a minute and an output rate of 125 cards a minute. **Data Processing Div., International Business Machines Corp.**, 112 E. Post Rd., White Plains, N. Y.

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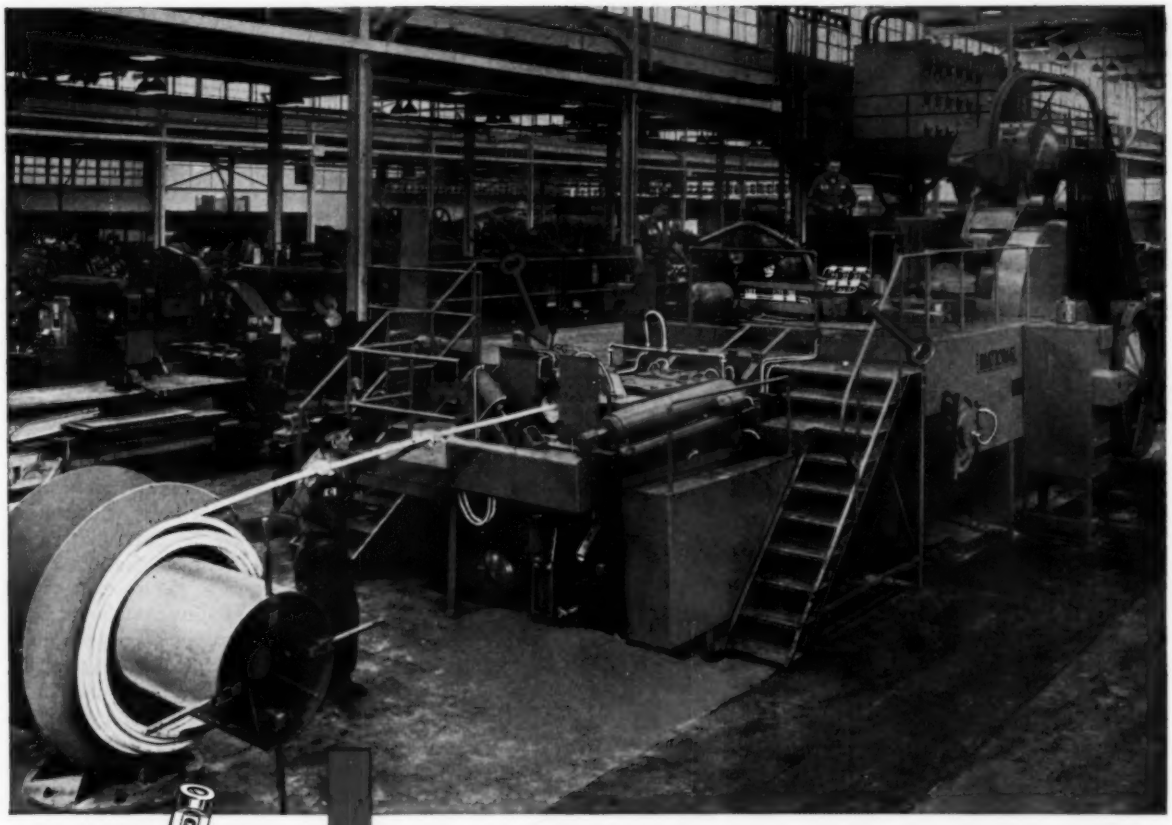


FARVAL—Studies in Centralized Lubrication No. 238

Farval automatically lubricates 138 bearings on world's largest Boltmaker

It's a 1¼-inch cold forger, designed and built by National Machinery Co. for the Cleveland Cap Screw Co., Cleveland, Ohio. This versatile machine automatically produces hex head cap screws. It draws steel rod to wire size, cuts it to proper length, extrudes the blank, heads, trims the head, points the end and then rolls on threads, all this at the rate of 38 complete screws per minute.

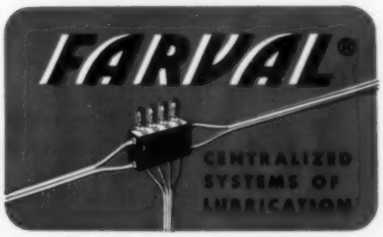
A Farval timeclock-controlled, motor-driven lubricating system guarantees against failure of the machine's 138 vital bearings, as well as supplying spray lubrication for the cold-forger's chain drive. If bearings should fail on such a high output machine—production costs skyrocket, profits take a nose-dive.

Write for revised Bulletin 26-T, which shows how Farval can extend both bearing and gear life on new machinery—as well as on older equipment now in use.

Farval Division • Eaton Manufacturing Company
3265 East 80th Street • Cleveland 4, Ohio

KEYS TO ADEQUATE LUBRICATION

Wherever you see the sign of Farval—familiar valve manifolds dual lubricant lines and central pumping station—you know steel mill equipment is being properly lubricated.



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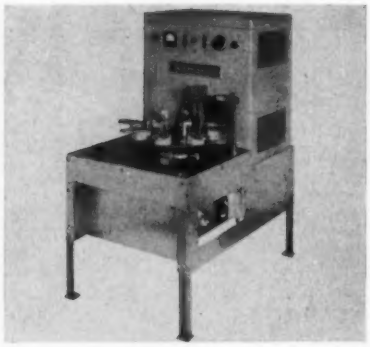

Soldering Device

Designed to meet requirements for high speed precision heating of various parts and assemblies, this induction heating device enables miniature components, usually very sensitive to heat, to be soldered in a few seconds with little or no flux and precise heating. Available Roto-Heater models: L6E-RH—2½ kw generator with Roto-Heater; L4E-RH—kw generator; L3F-RH—7½ kw generator; L4G-RH—10 kw generator. Features include electronic timer and contactor built-in for soldering of miniature components accurate to 1/100 second, and automatic or semiautomatic operated, indexing turntable. Once time cycles and settings are determined and set, the machine will operate by itself or can be activated by the operator who merely loads and unloads the parts. **Reeve Electronics Inc.**, 609 W. Lake St., Chicago 6, Ill.

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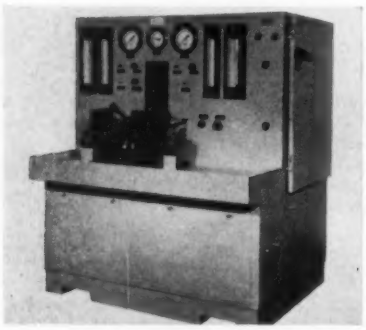

Valve Tester

Two variable area oil filter relief valve heads are simultaneously tested for leakage and flow on this production functional valve testing stand. Specially designed pressure control valves hold test pressures to within 1/10 psi through an 8 to 1 flow range while testing for flow. For leakage testing after the flow check, pressure is held to within 1/10 psi at no flow or slight leakage. Temperature is held to 1 degree for a range up to 250 F. Production rates of 360 parts per hour are possible. Accept or reject indication is made by pilot light for operator part handling. All testing is automatically sequenced. Changes in fixturing, sequence, and flow values will adapt this machine to alternate valve testing. **Scans Associates Inc.**, 12940 Farmington Rd., Livonia, Mich.

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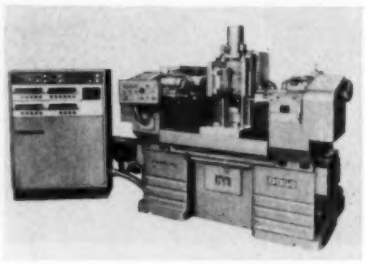

Boring Machine

Precision boring of several holes of various diameters and in selected locations is performed automatically and in sequence on this Numera-Trol machine. Machine not only positions the work in relation to the boring tool, but also adjusts the boring tool to the required hole diameter while the spindle is operating. Thus, single-point boring operations with infinite center locations and variable bore diameters within the limits of the machine are possible. Accuracy of hole diameter is held within 0.0005 inch; center locations are held within 0.0002 inch of true position; and boring depth is held within ±0.0005 inch. A special tool control mechanism accepts numerical commands to control the radius of tool rotation. A boring bar insert determines the actual size range; a number of sizes are available. Holes are bored from both ends on the same centerline to hold concentricity within very close tolerances. **Ex-Cell-O Corp.**, 1200 Oakman Blvd., Detroit 32, Mich.

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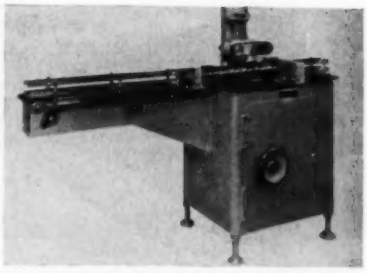

Code Marking Machines

Code daters will mark the bottoms of jars, bottles, cans, or aerosol containers at speeds up to 600 per minute, depending upon size and style of container. They are designed to function as an independent unit without dependence upon other components of a packaging line. Installation consists simply of replacing a section of conveyor of the line with a dating machine. Containers are automatically indexed and dated as rapidly as received. Standard Model 2-S accommodates containers ranging from 1½ to 3½ inches in diameter, and from 3 to 9 inches high with appropriate change parts. **John R. Nalbach Engineering Co.**, 6139 W. Ogden Ave., Chicago 50, Ill.

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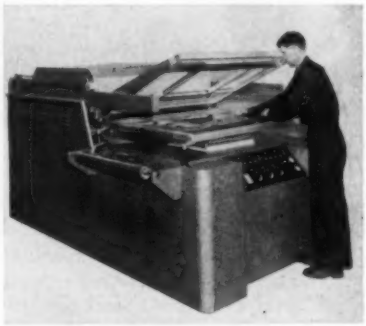
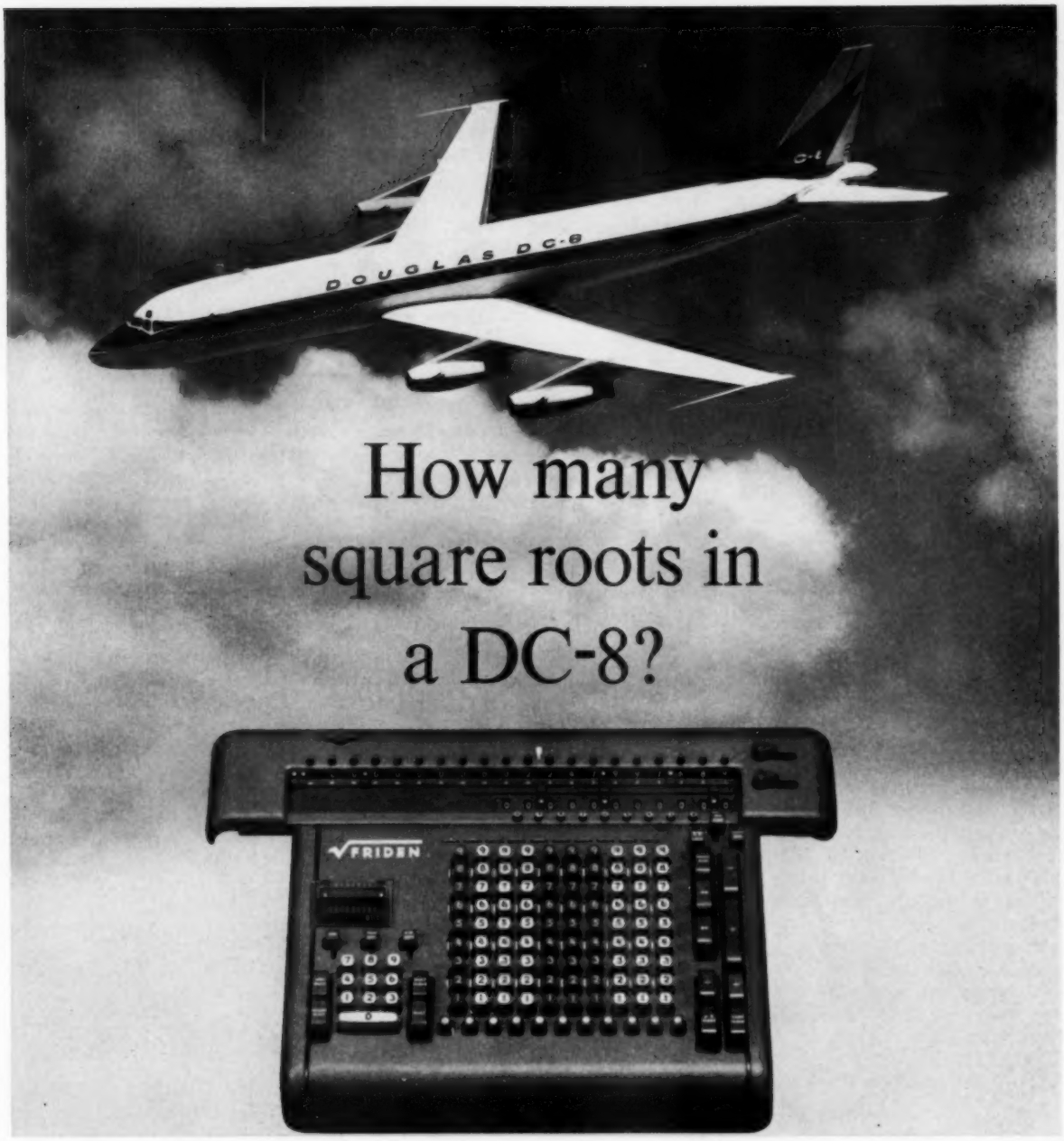


Vacuum Forming Machine

Machine has been developed for use in the plastic and packaging industry where vacuum forming, vacuum drape forming, or drape plug assist forming is required. Machine also provides three positions for skin packaging. Material can be fed into the machine automatically for high production through efficient roll and sheet feeders furnished as accessories. Model V is available in the fol-



How many square roots in a DC-8?

Thousands? *Tens* of thousands would be more like it. The point is this: if Douglas had used conventional methods of extracting those square roots, the DC-8 would probably have been longer getting off the ground. Ordinary square root methods are both a man-hour bottleneck and a constant source of errors.

How *does* Douglas get its square roots? With the Friden SRW... the only desk calculator in the world that automatically extracts square roots at the touch of a key. Douglas has 54 SRW's. And would hate to have to do without them.

You might not need 54 machines, but it's a rare engineering department that couldn't profit by the addition of at least *one* of these versatile engineering calculators. Ask your local Friden Man to show you what it can do. Or write: Friden, Inc., San Leandro, Calif.

THIS IS PRACTIMATION: automation so hand-in-hand with practicality there can be no other word for it.

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Friden

Sales, Service and Instruction Throughout the U.S. and World

Circle 690 on Page 35

lowing standard mold sizes: 20 by 25 inches; 24 by 34 inches; 34 by 42 inches; and 42 by 72 inches. Other sizes can be manufactured to specifications. Features include: Single switch dialing for all functions; a 3 kw/FT2 heating capacity; completely adjustable 16-inch drape stroke; self-locking adjustable oven height; and three timer controls. **Pacific Plastic Machinery Inc.**, 3443 S. Lawndale St., Chicago 23, Ill.

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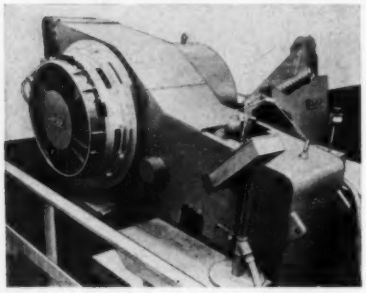

Can Extrusion Press

Horizontal extrusion machine for the manufacture of aluminum cans and containers is designed to operate at more than 200 strokes per minute. It extrudes the can in a single stroke from a 2.6 inch diameter by 0.164 inch thick slug and it is rated at 400 tons. The can is completely formed except for the rolling of the lip. This press is designed for use wherever canners wish to combine the advantages of aluminum cans with the economy and convenience of making cans on their own premises. **Verson Allsteel Press Co.**, 9300 S. Kenwood Ave., Chicago 19, Ill.

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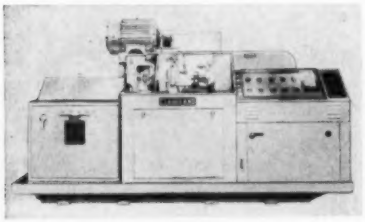

Chucking Machine

Single spindle automatic features a precision feed monitor dial that accurately indicates turret tool feed rates in inches per minute for each forward and return setting of the turret tools. A turn of a knob is all that is required to set the feed rates, and ten different infinitely variable feeds are possible in one cycle of the machine. A chart transposes spindle speeds and feeds into dial settings, and a turn of each knob sets the feed which is indicated by the monitor dial. This 3-inch Model AB has 112 spindle speeds, ranging from 24 to 1820 rpm. It can be easily converted from bar work to a chucking machine and it's capable of working pieces up to 6 inches in diameter. This is accomplished by the substitution of a simple chucking attachment for the bar feed assembly in the spindle. **Cleveland Automatic Machine Co.**, Cincinnati, Ohio.

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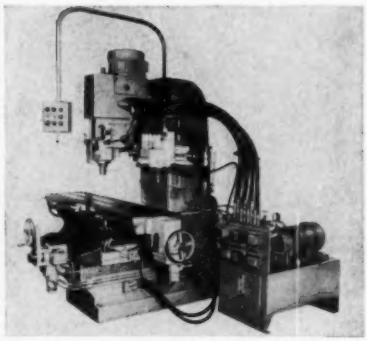

Vertical Milling Machine

Machine is convertible from duplicating to conventional milling in one minute. It is equipped with a 5 hp 1200 rpm motor 3/60/220-44 J.I.C. controls. Throat clearance of the head is 22 inches, vertical feed is infinitely adjustable, and vertical travel is 16 inches. Micrometer adjustable rotation is 45 degrees from center each side with positive stop on center optional. Longitudinal travel of the table is 36 inches; traverse travel, 16 inches. Table longitudinal power feed and traverse power feed are infinitely adjustable. Spindle speeds: 68 to 2400 (8 selections) changed by a selector level. Vertical travel of the spindle is 6 inches. The machine is equipped with a microhydro three dimensional hydraulic duplicating unit. **Visi-Trol Engineering Co.**, 12720 Burt Rd., Detroit 23, Mich.

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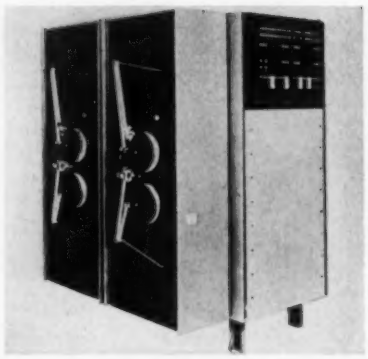

Data Converter

Tape to card converter, designated Data-Flo, is designed to complement an accounting machine by providing a means of producing punched cards from paper tape created on peripheral units. Cable connected and fully synchronized with a summary punch, the converter produces 80 column cards at rates ranging from 6000 to 7200 per hour depending upon type of punch employed. All operations are under full program control. Paper tape is read photoelectrically at the rate of 800 characters per second and checked before card punching. After punching each card is verified automatically. **Underwood Corp.**, 1 Park Ave., New York 16, N. Y.

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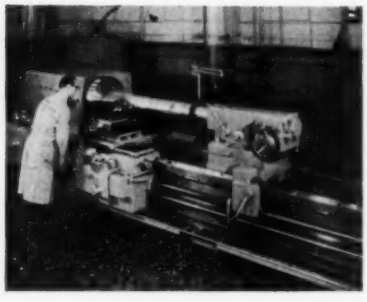

Engine Lathe

Seventy-five hp extra heavy duty engine lathe, Model 4025, has been developed for steel mill, foundry, and general machine shop work. The headstock provides 36 spindle speeds and 75 hp in all speed ranges. It features a 160 to 1 speed ratio in true geometric progression. Cutting speed is automatically calculated. This enables the machine to remove up to 180 cubic inches

All 'special' problems; yet all are solved by 30 standard LYNCH ROBO-LIFTS

When otherwise good conveyors cannot handle foods, drugs, hardware, chemicals . . . powders, solids, granules in the very very gentle, very very sanitary way required . . . with intake and discharge positions wherever required, Leaders Look To **LYNCH ROBO-LIFT.** Call the Lynch engineers. Whether it's handling raw materials, in process materials, or feeding a Robo-Wrap or other packaging machine . . . tell us all about your problem. Your most difficult problems are our best opportunities.

30 STANDARD MODELS—CAPACITIES: from 1.0 cfm to 40 cfm; 90 or 70 degree elevating angle; 10, 15, 20, 24 and 30 inch bucket sizes, stainless steel, or mild carbon steel; top and underdumps, height and length to meet any requirement.

ENGINEERING SERVICES: Should your materials handling problem be a troublesome one, send us the details. Perhaps one of our 30 *standard* Robo-Lifts will do the job. Specifications for special enclosures, drives, feeds and discharge arrangements on request.

LEADERS LOOK TO LYNCH— FOR MACHINES THAT PACKAGE ALMOST EVERYTHING!

Manufacturing engineers of automatic processing equipment for the glass, packaging, and other industries.

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ENGLEWOOD, NEW JERSEY

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CORPORATION
Anderson, Indiana, U.S.A.

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of metal per minute. Capable of handling stock up to 504 inches in length with a 40½ inch diameter swing over the bed and a 25½ inch swing over the compound, this lathe provides special rigidity because of its full width compound and three dimensional truss design of the bed. Features of the machine include a dual cam tumbler lock which overcomes possible gear and cone gear unlocking. **Sidney Machine Tool Co.**, Sidney, Ohio.

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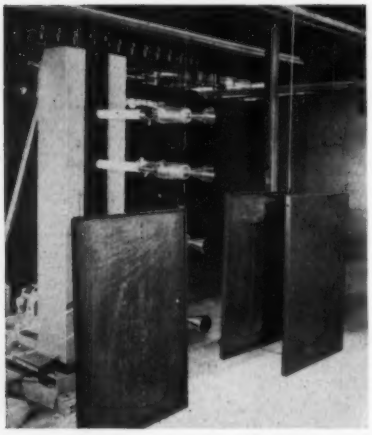

Production Painting

Units are ideally suited for production painting lines where grouping and batching of similar parts is impractical. Atomizers automatically paint articles of different sizes. As the size of the articles to be painted changes, automatic sensing devices reposition the No. 2 Electro-Spray process bell atomizers in and out to maintain correct painting distance. Paint is triggered on and off automatically by a metering valve to accommodate variations in length and spacing of articles on the line. Changes in height of work patterns are handled by turning the bells on and off selectively. Reciprocal motion of the bells produces an especially uniform, electrostatically deposited paint coating. In the application illustrated, only the two lower bells would be used to paint the short shelving parts. The upper bells would turn on selectively as higher parts come down the line. **Ransburg Electro-Coating Corp.**, Box 23122, Indianapolis 23, Ind.

Circle 421 on Page 35

Dial Feed Welder

Fully automatic welding system is designed to assemble and weld up to 300 subminiature electronic components per minute. It can be used with any standard ac or dc power supply and includes load stations to feed microscopic parts in its production of transistors, diodes, resistors, and other components. Controls for this continuous dial feed welder are furnished for either pushbutton control or continuous feed cycle. The welder operates on 115 or 120 v. **Commercial Apparatus & Systems Div., Raytheon Co.**, 1415 Providence Turnpike, Norwood, Mass.

Circle 422 on Page 35

Capsule Inspection Unit

High speed tablet and capsule inspection unit, designated Model A-1000 Accep-Tron, can be used to reject coreless, press-coated tablets and empty capsules; separate two or more groups of tablets that have been simultaneously pan-coated; separate placebos from special formula sample tablets; and recover cores from crushed tablets. The device illustrated applies a concentrated magnetic field to separate products containing a trace of magnetic material. The tracer material is included in either the medicinal core or a product additive. This inspection equipment has sufficient sensitivity to allow the tracer in proportions as low as one part in one thousand. It will inspect and sort up to 3000 tablets per minute. Input chutes for ¼, ⅜ or ½ inch-diameter products are provided as needed. **Arthur Colton Co., Div., Snyder Corp.**, 3400 E. Lafayette, Detroit 7, Mich.

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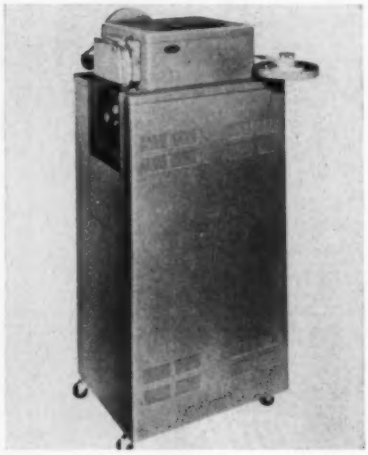


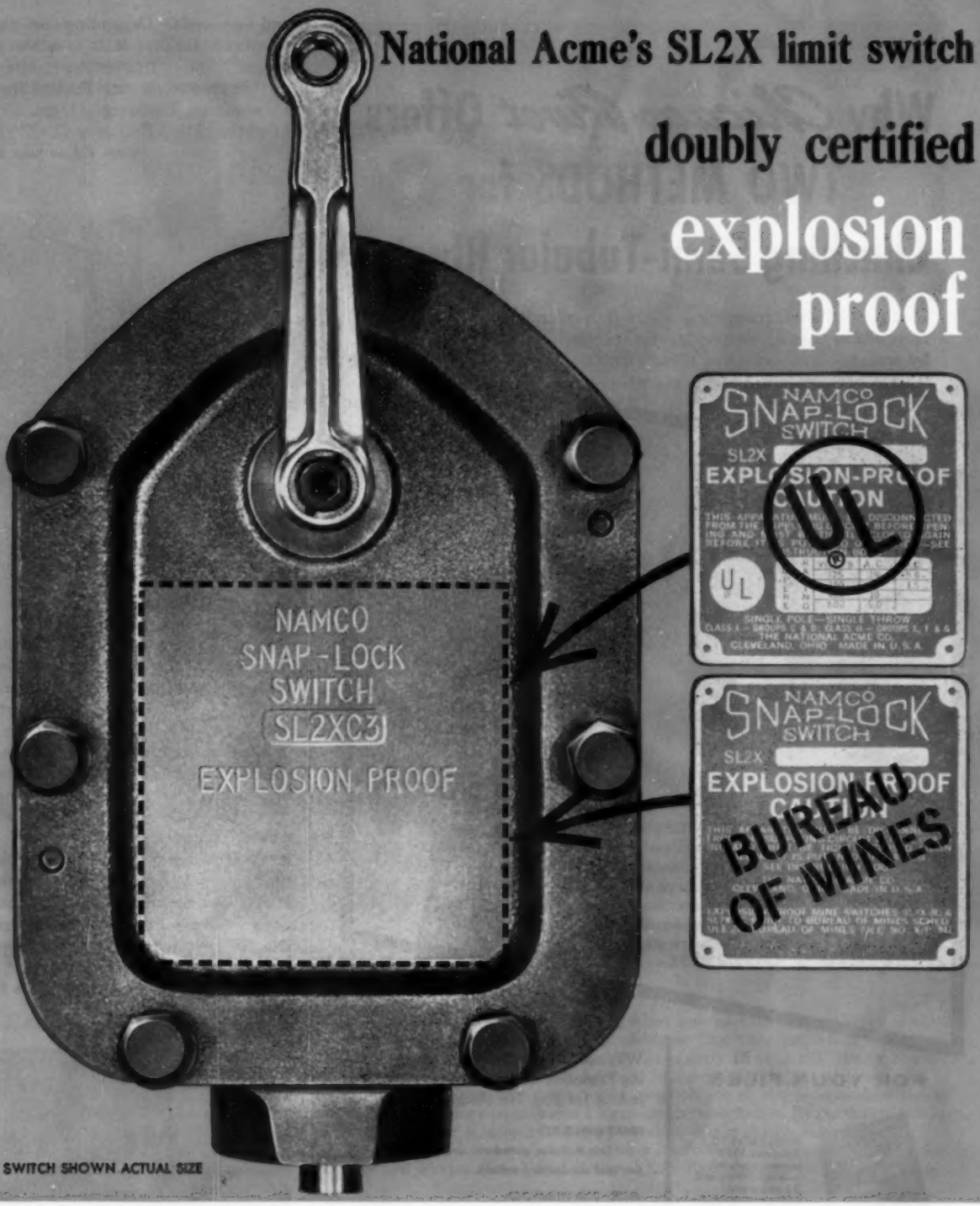
Transmitter-Receiver

Eight-channel code transmitter-receiver provides for the transmission of a single, continuous tape at double the speed of a standard model. This is accomplished by transmitting alternately over two transmission channels, each operating at a normal speed of 75 bits per second. The Dual Teledata transmitter-receiver has been designed for operation in either half- or full-duplex systems. In a half-duplex system it is possible to transmit 850 characters per minute in either direction, but not both directions simultaneously. Full-duplex indicates that information may be transmitted in both directions at the same time. This allows for 850 characters in both directions. The device reads 8-channel tape containing any type 7 bit, self-checking codes in 7 channels, with provision for reproducing the 8th bit when used with carriage return or

National Acme's SL2X limit switch

doubly certified

explosion proof



SWITCH SHOWN ACTUAL SIZE

Specify National Acme's SL2X . . . and eliminate limit switching problems under explosive conditions. Tested and certified "explosion-proof" by both Underwriters' Laboratories and the Bureau of Mines, the SL2X is specifically designed for use in the mining, chemical, process industries . . . anywhere explosions cannot be tolerated. Latest of National Acme's dependable SL2 "Machine Life" Limit Switches, the SL2X also offers . . . a variety of cam arrangements for extreme operating flexibility . . . ample overtravel (67°) and by-pass (90°) . . . light operating pressure (12½ lbs. at 1½" radius). Get all the details on this new standard of limit switching dependability and safety. Call, write or wire.

National Acme

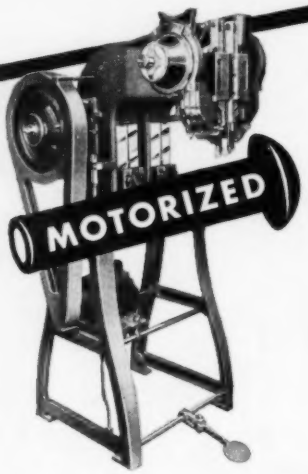
THE NATIONAL ACME COMPANY
196 E. 131st STREET
CLEVELAND 8, OHIO

Sales Offices: Newark 2, N. J., Chicago 6, Ill., Detroit 27, Mich.

Circle 692 on Page 35

Why *Chicago Rivet* Offers TWO METHODS for Clinching Semi-Tubular Rivets

It is part of a widening service based upon industry's recognition that an assembly held together by semi-tubular rivets has great inherent strength and is usually lowest in production cost.



The Chicago Rivet MOTORIZED AUTOMATIC RIVET SETTER produces a sharp, solid blow that immediately upsets the tubular section. This method is used on 95% of all applications involving metals or non-fragile materials.

The Chicago Rivet AIRPOWERED RIVETER produces a cushioned, shock-free clinch on a tubular rivet, permitting riveting of fragile and uneven materials. This method has greatly widened the use of semi-tubular rivets.

FOR YOUR FILES

RIVET CATALOG describes 1388 standard tubular and split rivets and 25 single and multiple motorized automatic rivet setters.

AIR-POWERED RIVETING catalog contains description and specifications of 8 single and multiple riveters—also rivet setters designed for automated operation.

Why not let Chicago Rivet Fastening Engineers tell you which system is best for you. No obligation.

MOTORIZED

Line includes automatic single, multiple and automated setters.

AIR-POWERED

Line includes automatic single, multiple and automated setters.

Chicago Rivet
& MACHINE CO.
943 So. 25th Ave., Bellwood, Ill.
(Chicago Suburb) Branch Factory: Tyrone, Pa.

end-line code. Depending on the telephone facility, it is possible to utilize four transmitter-receivers on the same circuit. **Friden Inc.**, Promotion Planning Dept., 1 Leighton Ave., Rochester 2, N. Y.

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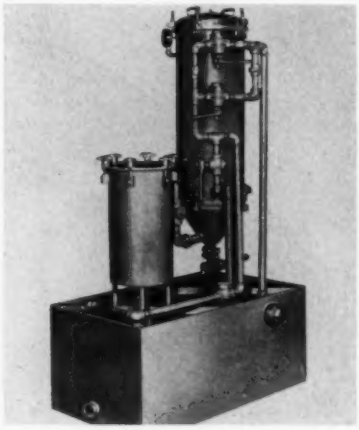

Coolant Filter

Unit is designed for use with honing machines, small precision grinders, and spark disintegrators. It supplies clean coolant and prevents wheel loading and wedging of small chips between the tool and the work, thus giving longer wheel or tool life. Package precoat-type filter has only two filter control valves. Back flushing takes only a few minutes and the complete filter cycle takes less than five. Crystal clarity is common with this machine. **Olson Filtration Engineers, Div., American Laundry Machinery Co.**, Cincinnati 12, Ohio.

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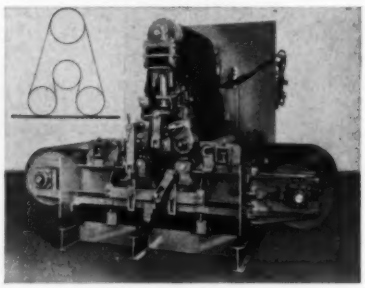
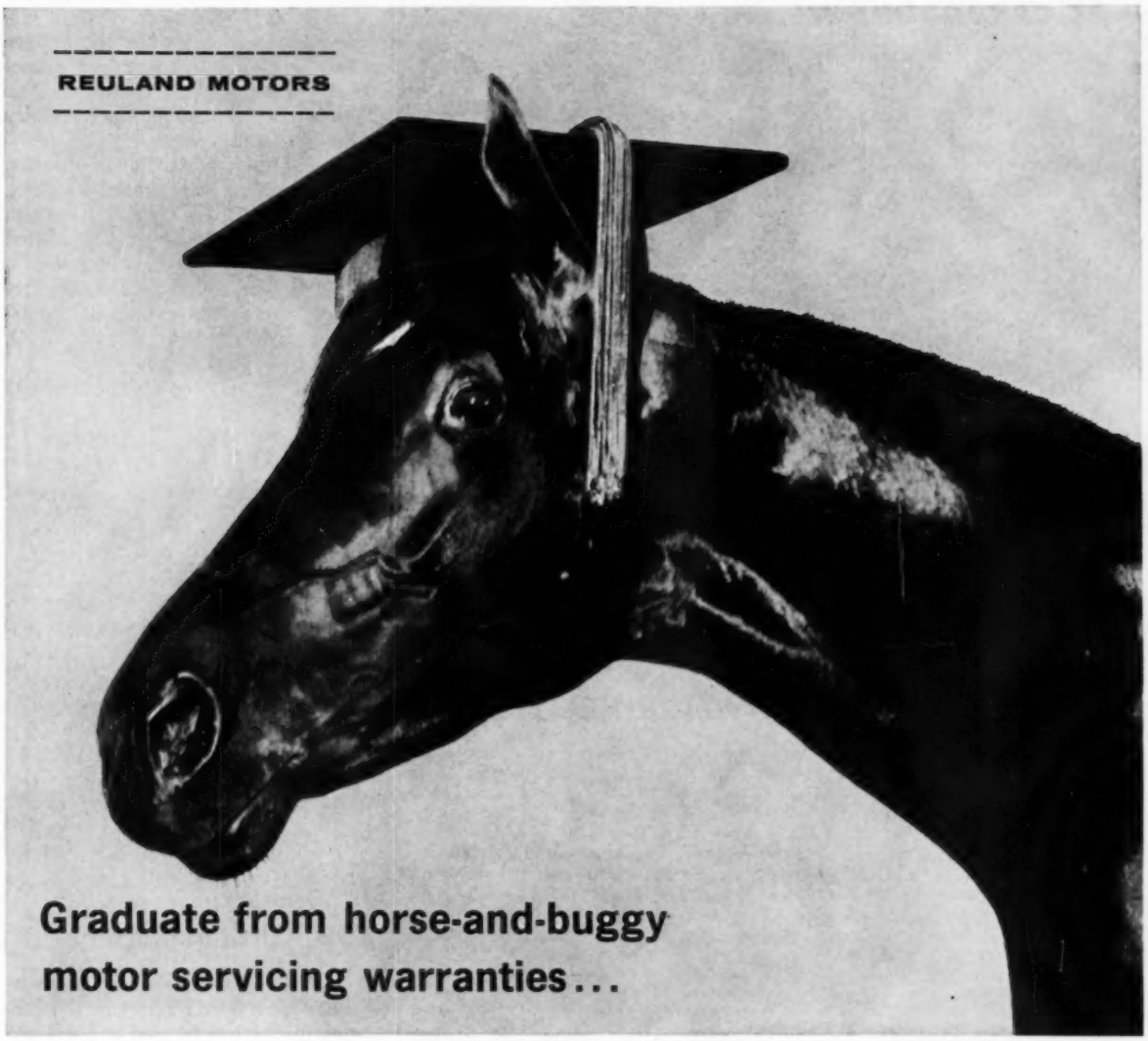


Sheet Polisher

Sheet polishing machine for wood, metal, plastics, etc. utilizes a single, endless, abrasive belt which makes

REULAND MOTORS



Graduate from horse-and-buggy motor servicing warranties...

with REULAND's "Honor System Motor Service Policy!"

Reuland's 15 year old service policy takes the word of any motor service shop of your choice.

Whether you're an O.E.M. or a User, when you buy REULAND electric motors you can make your decision with confidence. One very important reason, of course, is that every motor is backed by REULAND's 15 year old "Honor System Motor Service Policy"... *still* the only one in the industry!

Under this exclusive service policy, *your* choice of any independent motor service shop becomes an authorized REULAND service station. Regardless of where a REULAND motor is in operation, approved service is always next door!

If you would like to talk to a motor manufacturer who really backs up his quality and service claims, find out soon how REULAND can fit into your plans.

EVERY COMPANY SHOULD HAVE A COPY OF REULAND'S OFFICIAL, PRINTED "HONOR SYSTEM SERVICE POLICY!"

A free copy is available on request. Explains the simple steps to take. Shows how Reuland's unique philosophy of doing business permits it to offer the industry's only Honor System Motor Service Policy. We'll mail yours promptly.

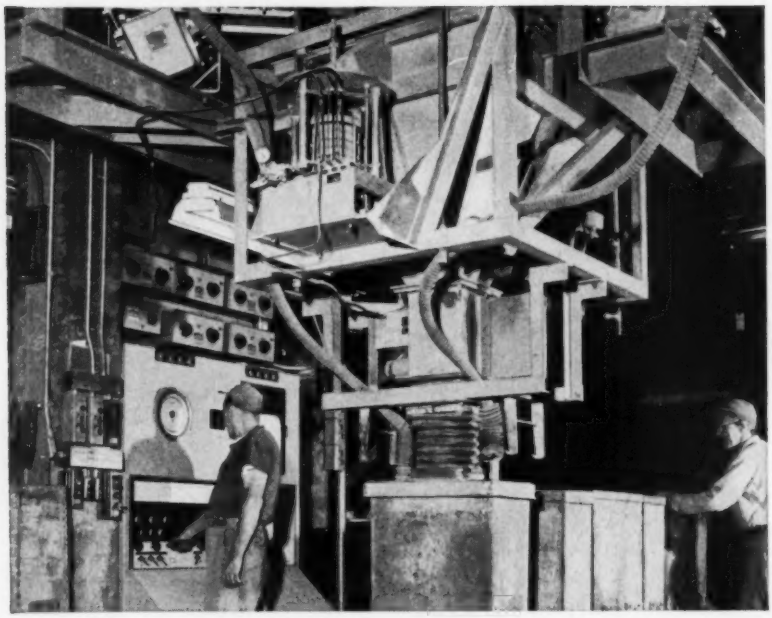
Our new 8-page general line brochure will come in handy! Also, refer to Sweet's 1961 Product Design File, 7a/RE.

MODERN POWER FOR MODERN-DAY PRODUCTS... *all in lightweight, cool-running aluminum frames!*

REULAND MOTORS RE®

REULAND ELECTRIC COMPANY
Western Division—Alhambra, Calif.
Eastern Division—Howell, Michigan
Distributors in all principal cities

AT CARBORUNDUM...



Accuracy and Instantaneous Control Response with W & C BATCH-WEIGHING SYSTEMS

Critical formulation standards are maintained at lower cost since Carborundum Company has introduced automatic batching of ingredients at their Perth Amboy, N. J. refractories manufacturing plant. The new automatic system—designed with W & C pre-engineered and laboratory-tested "building block" components—has greatly increased production, reduced labor costs, and decidedly improved the accuracy of batch weight control.

Chief reason for the accuracy of W & C Batch-Weighing Systems is the patented Uniforce flexural frame used in supporting both weigh-hoppers and weight transmitters. These unique flexural frames ensure accurate weighing under *all* load conditions, resolve *every* force and moment into a single vertical component applied to the load transducer.

Immediate response to control material flow in *any* batching operation is provided by the W & C Pneumatic Weight Transmitter, a force-balance instrument delivering a highly reproducible, (1 part in 2000) almost *instantaneous* signal directly proportional to net weight. No possibility of overshooting specified ingredient quantities. Practically no maintenance, compared with mechanical systems. The W & C scale is dynamically faster than a beam-and-balance or flexural beam system . . . W & C uses air, has no inertial mass to overcome . . . comes into balance sooner than a mechanical system.

For *consistently* accurate reproduction of bulk material formulations in any batching operation—single ingredient weighing to sequential multi-ingredient proportioning—you can depend on W & C.

WRITE FOR BULLETINS / Bulletin 30 fully describes W & C Batch-Weighing Systems
Bulletin 14 describes other W & C Automatic Weighing Systems

WC 1100

CONVEYOR SCALE SYSTEM

CONSTANT-FEED WEIGH-HOPPER SYSTEMS

CHECK-WEIGHING SYSTEMS

CONTROL PANELS

See page 644 Chemical Engineering Catalog for list of representatives

W & C

Weighing & Controls, Inc.
Subsidiary of **CompuDyne Corporation**
Industrial Park, E. County Line Road, Hatboro 10, Pa.

contact with the work twice in one pass, providing double the surface finishing ability of standard single-contact flat polishing machines. The abrasive belt may be operated dry or with a mist spray or belt greasing to produce decorative finishes. Dual contact rolls are oil resistant, statically and dynamically balanced, and rubber-covered to any desired density. Backlash is eliminated by a special gear coupling, and selective drive speeds range from 20 to 60 fpm. **Murray-Way Corp.**, P. O. Box 180, Birmingham, Mich.

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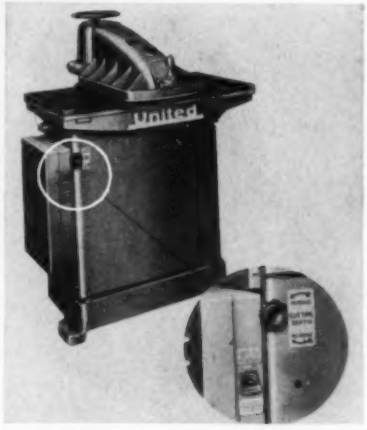

Die Cutting Machine

Stroke control switching arrangement permits this Hytronic die cutting machine to be used as a straight hydraulic as well as an electronically self-controlled stroke cutting machine. It allows for the cutting of conductive materials as well as nonconductive materials. Machine has been used in such industries as shoes and leather, plastics, clothing, paperboard, and others where nonconductive sheet material must be cut rapidly and with great precision. When the die cuts through a nonconductive material, it makes contact with a special, conductive cutting surface, and this completes an electronic circuit which instantly reverses the motion of the beam, returning it to its raised position. The switch arrangement eliminates the plate-to-ground contact and converts the cutter into a straight hydraulic machine. **United Shoe Machinery Corp.**, 140 Federal St., Boston 7, Mass.

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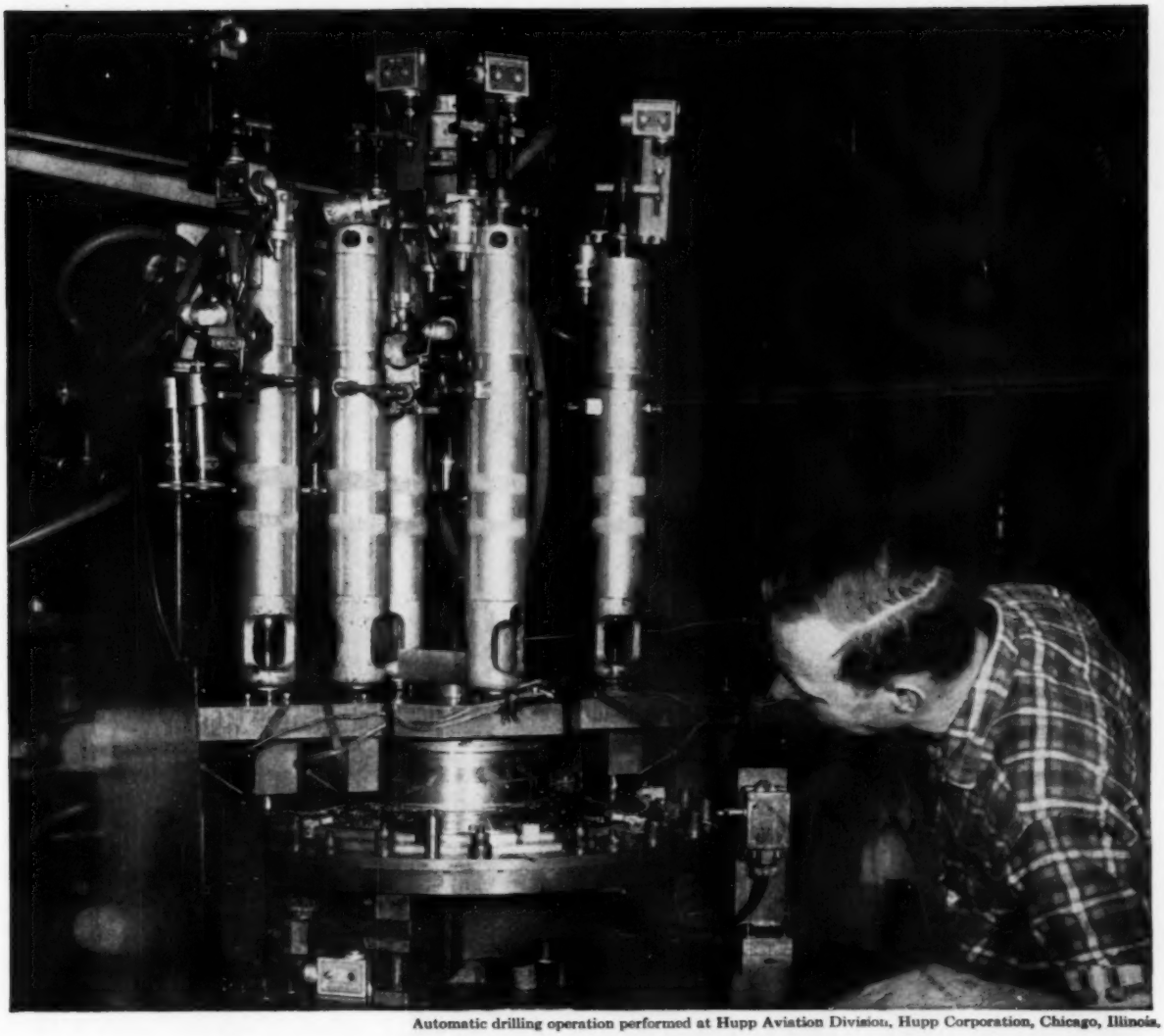


Automatic drilling operation performed at Hupp Aviation Division, Hupp Corporation, Chicago, Illinois.

Airfeedrills® cut drilling time 88% on jet aircraft part

Time required for drilling 104 holes in a bearing support for a jet aircraft compressor was cut 88% when the manufacturer switched from other methods to five Gardner-Denver "Airfeedrills."

Three bolt circles were drilled at two different levels; 72, 8 and 24 holes were drilled in bolt circles 18⅛", 10.2" and 8.5" respectively. All holes in the material—AMS-6415—were drilled to close Air Force tolerances. A 36-station index table, plus automatic "Airfeedrill" controls, automated the entire operation.

VERSATILITY AND INTERCHANGEABILITY

This is just one more example of the versatility and interchangeability of Gardner-Denver "Airfeedrills." They're easily adapted to almost any drilling setup. You mount them as a drilling unit of 2, 20 or more spindles for automatic hole processing. Use one as a stationary drill mounted on an inexpensive fixture. As a portable drill, "Airfeedrill" hangs by its nose to a jig for precision drilling.

See for yourself how quickly and inexpensively you can automate *your* drilling operations . . . see your Gardner-Denver representative or write for Bulletin 92-1 on "Airfeedrill" specifications and applications.

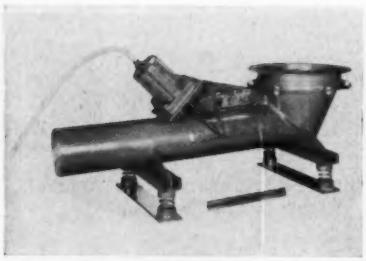
EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

Circle 696 on Page 35



Vibrating Conveyors

Air-powered vibrating conveyors are capable of moving bulk quantities of pelleted metals without dust or contamination problems. A vibratory drive, air-cushioned for quiet operation, powers the totally-enclosed aluminum conveyors. Flow is started and stopped by a quick acting valve and can be regulated by adjusting the air supply pressure. The conveyor illustrated is installed in an aluminum plant and carries aluminum pellets with a density of 65 lb per cubic ft from a bin to a blower system at a rate of 20 tons an hour. Conveyors may be installed as low as 6 in. above the floor. Vibrating conveyors may also hang overhead with the vibratory unit located beneath the conveyor tube. Conveyors up to 20 ft in length may be powered by a single unit. They operate on 10 to 100 lb air pressure. **Cleveland Vibrator Co.**, 2828 Clinton Ave., Cleveland 13, Ohio.

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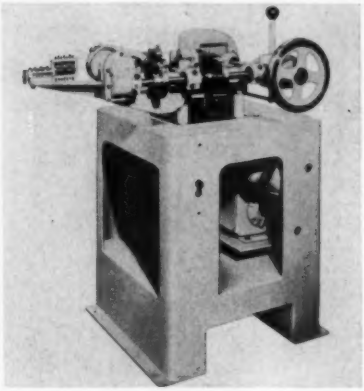


Cutting-Off Machine

Machine is capable of straightening and cutting-off short lengths of round wire up to 3 inches and in sizes up to 0.045 inch diameter basic wire (to 0.060 inch soft material), or its equivalent in ribbon metal in widths to 3/8 inch. Lengths are cut off at rates up to 400 per minute. Tolerance is held to ±0.002 inch on feed lengths, and using a secondary cutoff attachment, tolerance is maintained at zero. The SC-00 straightening and cutting-off machine can produce parts with square-cut, divergent-cut, or a combination of these cuts on a given length of wire. It can be tooled to perform a variety of secondary operations such as forming, heading, coining or piercing, and winding. **A. H. Nilson Machine Co.**, 1400 Bridgeport Ave., Shelton, Conn.

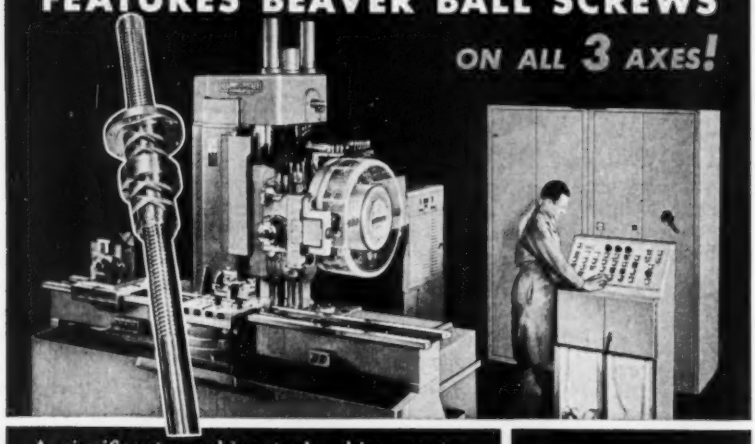
Circle 429 on Page 35

Gravity Water Filter

Filter is ideally suited for both municipal and industrial use. A siphon is combined with a filter bed in a compartmented tank, and performs the backwash operation automatically. There are no pumps, valves, gages, or manual or electric controls anywhere in the unit. Actuation of the backwash cycle is accomplished at exactly the optimum moment without any outside aid; the filter cannot over or underwash, and backwash or rinse water cannot be accidentally run to service. The unit operates on a loss-of-head and can be used wherever gravity feed is feasible. The filter bed contains standard fine filter sand supported on a collection system of disc-type plastic strainers. Other types of filtering material, such as anthracite, or Neutralite, can be employed simply by modifying the rate of wash. **Permutit Co.**, 53 W. 43rd St., New York 36, N. Y.

Circle 430 on Page 35

K & T'S MILWAUKEE-MATIC
TAPE-CONTROLLED MACHINING CENTER
FEATURES BEAVER BALL SCREWS
ON ALL 3 AXES!



A significant machine tool achievement—Milwaukee-matic numerically controls positioning, tool selection, indexing, machining, speeds and feeds. Preloaded Beaver Ball Screws with the inherent precision, essential in data control, were the choice of Kearney & Trecker designers for spindle positioning, cross feed and table feed—just as they are with most builders of numerically controlled machines.

Our engineers will be glad to work with you.

Beaver Precision Products INC.
CLAWSON, MICH.

Circle 697 on Page 25

Punch Riveter

Portable punch riveter is ideal for automatic punching and riveting that cannot be handled on stationary riveters. It stores approximately 500 flush or round-head rivets in the pneumatically driven rotating drum that automatically drops them into place. The 50-pound device punches a hole, places the rivet, and heads the rivet in less than two seconds. It is furnished with a cable type balancer for overhead suspension and is constructed so that it also can be permanently installed on a workbench. The riveter is a one-eighth-inch machine of the pneumatic squeeze type. Punching and riveting action is controlled by a finger trigger and a hand grip. **ACF Electronics Div., ACF Industries Inc.**, Riverdale, Md.

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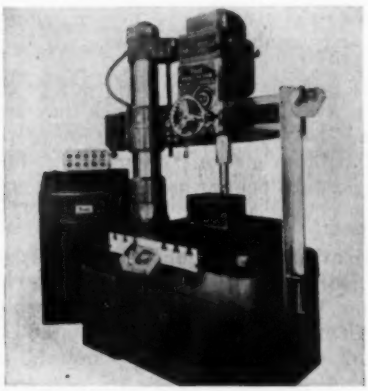

Drilling Machines

Precision hole locating in two directions can now be performed quickly and accurately on these Veetmatic radial drilling and boring machines. Model 3-M is equipped with semiautomatic positioning which is accomplished by setting up X and Y axis spacing with gage blocks, end measurers, or bar micrometers. This method of approaching jig bore accuracy is ideal for toolroom jobs and small lot production jobs. Card controlled Model 3-C uses I.B.M. cards on which you punch out the blueprint dimensions for each job. Tape controlled Model 3-T operates from standard 8-channel tape as prepared on a Friden or Flexowriter, providing fully automatic loading of holes in two directions to an accuracy of ±0.001, with high repeatability. **Veet Industries**, 25753 Groesbeck Highway, East Detroit, Mich.

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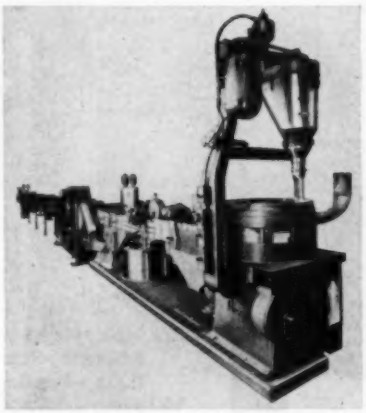

Carton Filling System

Auger filling system has been developed for a Neverstop line of automatic carton filling and sealing machines. These machines handle such items as non free-flowing powders, granules, and dry materials which tend to bridge or pack. With this new method it is expected that such products as dessert powders, pancake mixes, gelatins, powdered sugar, etc. can now be handled at speeds up to 400 per minute. The product material is driven down by the constantly rotating action of an auger to increase speed and provide better control over product flow. End opening cartons of practically any type can be handled from small one oz to three lb sizes with dimensions of 3 by 2 by ¾ inches up to 12¾ by 18¾ by 3¾ inches. **FMC Packaging Machinery Div.**, Stokes & Smith Plant, 4900 Summerdale Ave., Philadelphia 24, Pa.

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BEAVER

BALL SCREWS

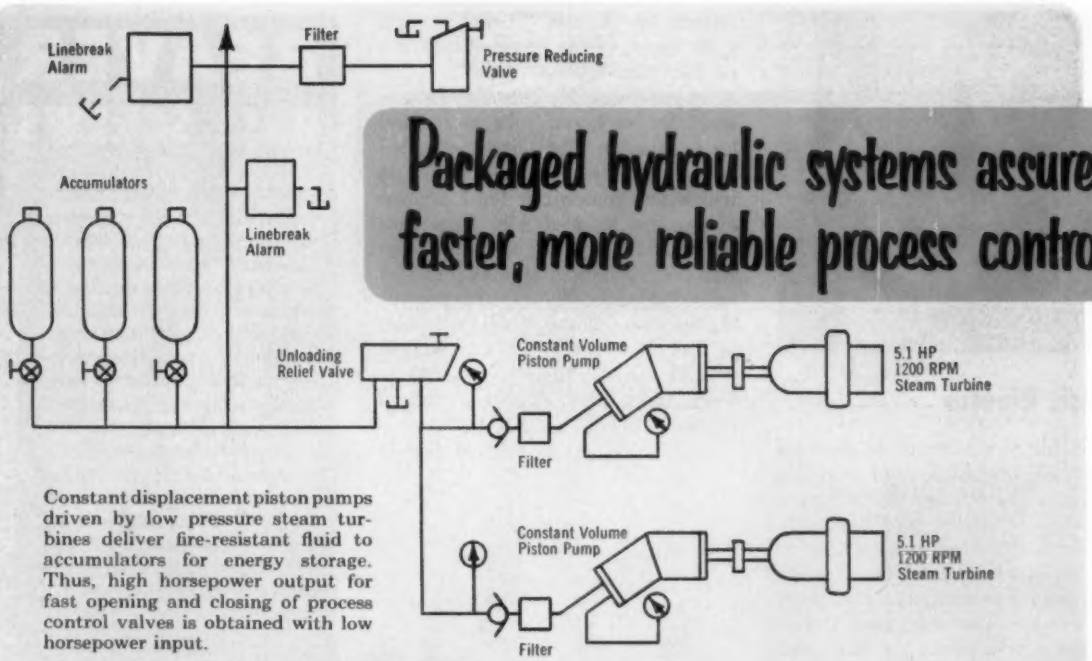
Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficient in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments, aircraft, machine tools, massive wind tunnel jacks, etc. For horizontal and vertical actions, indexing, inching and traversing. Consultation and engineering service available. Write for literature.

• EXTREME ACCURATE POSITIONING • NO BACKLASH • RAPID START • ANY DIAMETER OR TRAVEL •

Beaver Precision Products INC.
CLAWSON, MICH.

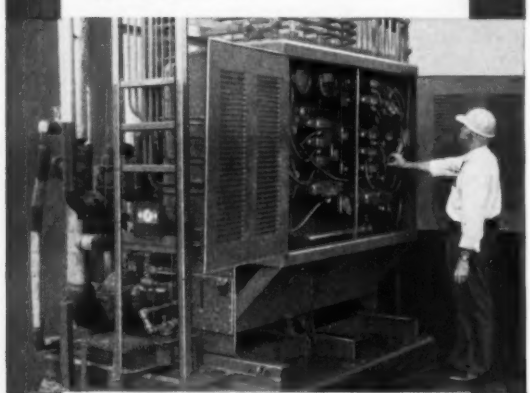
Circle 698 on Page 35

Packaged hydraulic systems assure faster, more reliable process control



Constant displacement piston pumps driven by low pressure steam turbines deliver fire-resistant fluid to accumulators for energy storage. Thus, high horsepower output for fast opening and closing of process control valves is obtained with low horsepower input.

Control console and power unit form electro-hydraulic system for controlling automatic heat treatment cycle. Physical layout provides optimum circuit efficiency, ease of servicing, and good appearance.



This power package includes all hydraulic pumps and valves for complete control of automatic cyclic operation of process in a butadiene plant.

Fast and precisely controlled motions, having the high reliability demanded by modern processing, are inherent characteristics of hydraulics. In addition, these advantages are obtained at low cost, for you can cover your full range of operations—from valve control to power transmission—with standard Vickers components. Your engineers enjoy unlimited design flexibility through a choice of electric, electronic, pneumatic and manual signals to control the hydraulic pumps, motors, cylinders, and variable speed drives.

Vickers complete packaged systems are ready to go into service upon arrival in your plant, since they are thoroughly pretested before shipment. They are properly designed and built to give maximum service life with little downtime, thus helping to keep your plant on stream.

Get more information on the job being done by Vickers packaged hydraulic systems in chemical, petrochemical, petroleum refining, and other processing industries by writing today for Bulletin I5802, "Packaged Hydraulic Systems for Process Control."

VICKERS INCORPORATED
DIVISION SPERRY RAND CORPORATION
ADMINISTRATIVE and ENGINEERING CENTER
Department 1536 • Detroit 32, Michigan

9138

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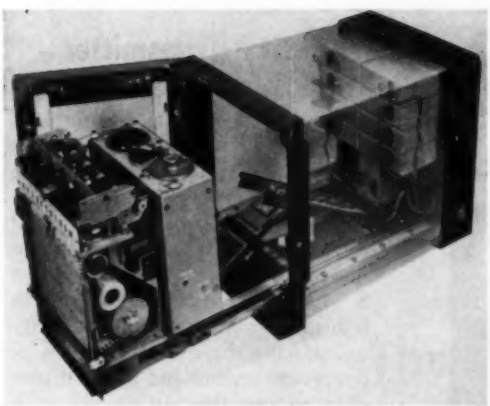
AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use card page 35.



Strip chart model, showing display, drive and case modules, can be quickly converted to circular chart recorder or circular scale indicator. Drive module encloses newly developed electromechanical strain gage, range card and circuit board, amplifer, and constant current unit. Case module houses display and drive units, drawer-type chassis permitting uninterrupted operation, wiring drawbridge, control units, power supply for control system, and terminal board.

Self-Balancing Potentiometer

DEVELOPED by **Brown Instruments Div., Minneapolis-Honeywell Regulator Co.**, Wayne and Windrim Avenues, Philadelphia 44, Pa., this industrial process potentiometer can be used as a recorder for both temperature and nontemperature applications. It features a stable, trouble-free electromechanical strain gage, the Stranducer unit, that varies the output potential of the measuring circuit to balance the input signal from the process variable.

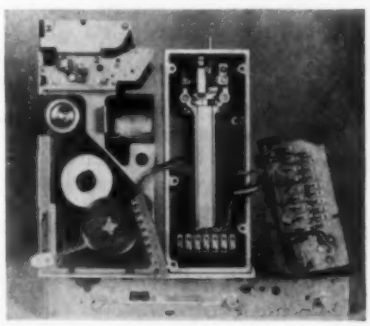
All critical components are isolated within an electrical shield, thus rejecting stray signals that can cause recording errors and affect the dynamics of the instrument. Stray signals having 60-cycle rms values five times greater than span, and voltage to ground stray of 300 v dc or 150 v ac, will not impair the accuracy of the Electronik 17 potentiometer. One true reference junction compensates for all types of thermocouple actuation.

This unit is equipped with plug-in control units with up to a maximum of 8 points for auxiliary or zone control. Any combination of these can be supplied as original equipment or modified as required. Compact transistor units control the contact action of single-pole, double-throw relays, and a single plug-in power supply furnishes input signals to all control system components.

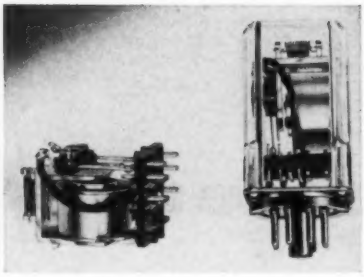
This potentiometer is available in three basic models: Strip chart recorder, circular chart recorder, and circular scale indicator. It can be converted from a strip chart instrument to a circular chart or a circular scale one, by changing the display module. A cascaded zener diode network provides a constant current to the measuring circuit despite fluctuations in line voltage and changes in ambient temperature. Each module is a complete interchangeable assembly or subassembly. The drive module, which contains the measuring circuit, the strain gage, constant current unit, input filter, converter, amplifier, and balancing motor, is common and identical on all models. A second recording pen system can be added easily to the strip chart model.

Potentiometer can be mounted in a standard 19-inch relay rack, on a panel or bench, or made portable. Characteristics include: Greater than 100,000-ohm input impedance with up to 50,000 ohms allowable source impedance; 31-day ink supply; electric contact control with a maximum of 1/5 per cent dead band; pen speeds of 1, 5, and 15 seconds on strip chart instruments and 5 and 15 seconds on circular instruments; and ± 0.25 per cent calibrated accuracy.

Circle 434 on Page 35



Outlined to prominently show its application in Electronik 17 potentiometers is a new rebalancing mechanism, the Stranducer, an electromechanical strain gage that eliminates conventional slidewire. Cover plate is removed to show position of the gage in drive module common to this particular potentiometer line.



General Purpose Relays

Series GH general purpose relay line has been improved to assure a longer, trouble-free operating life. A riveted crossbar replaces the screwed down type, a linen-based phenolic insulator between the crossbar and armature replaces the paper-based phenolic insulator, and the wires from the crossbar to the front panel are 20 gage rope-lay type to insure ample current carrying capacity and to resist wire breakage from operation. The GHA (5 amp) and GHB (10 amp) open series carry UL approval. This series continues to offer the same wide range of coil voltages, mounting and contact arrangements in both open and dust tight enclosures. **Electronics Div., Elgin Advance Relays, Elgin National Watch Co.**, 2435 N. Naomi St., Burbank, Calif.

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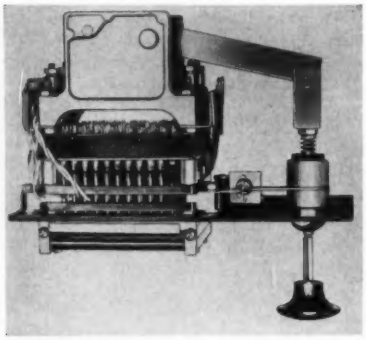
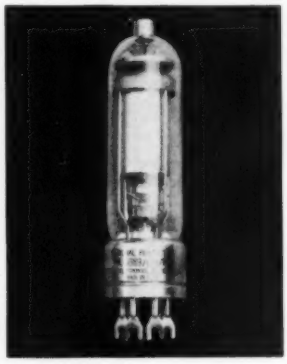


Card Reader

Cardmatic card reader is furnished in a standard wiring configuration with 186 individual, unwired bottom contacts and grouping of the upper deck contacts as follows: 10 columns of 17 contacts tied together and one column of 16 contacts tied together (a total of 11 column strips wired to 11 external terminals). Typical applications include punched card test programming, punched card programming of food processing operation, and punched card programming in teaching machine. Specifications: Contact resistance, 0.005 ohms nominal, contact-to-pin-to-contact or 0.0025 ohms nominal, contact-to-pin only; current rating, 10 amp; possible switching combinations 12.6 by 10^{56}; code cards, standard 3 by 5-inch modulars. Momentary control solenoid trip mechanism automatically actuates all desired contacts simultaneously. Contact arrangement can be easily changed or redesigned to meet individual requirements. **Hickok Electrical Instrument Co.**, 10514 Dupont Ave., Cleveland 8, Ohio.

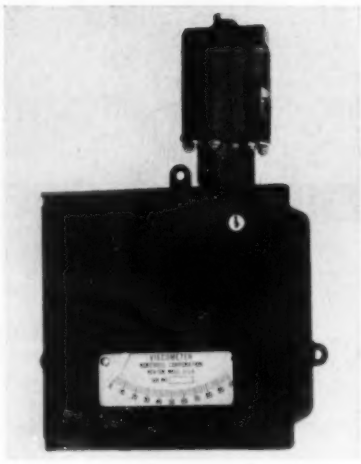
Circle 436 on Page 35



High Current Thyratron

This 6.4 amp, 1000 v peak forward and 1250 v peak inverse thyratron, designated Model NL-6989/C6J/KL, is designed especially for welding control, motor speed control, and regulated rectifier applications. It has a high commutation factor, 130 V/microsec by A/microsec, which makes it useful in equipment involving rapid application of inverse voltage after conduction. Ratings are: Filament volts, 2.5; filament current, 21 amperes; peak anode current, 80 amp; and ambient temperature limits of −55 C to +75 C. This tube features a standard lug base. It is also available with a pin base and bracket base, Models NL-C6J/K and NL-C6J/KP respectively. **National Electronics Inc.**, Geneva, Ill.

Circle 437 on Page 35



Viscosity Transmitter

Viscosity indicating pneumatic transmitter is suitable for use with any of a line of measuring elements that have been designed to measure in open tanks, pressure or vacuum vessels, or in pipe lines. Model IP receives an electrical signal from a measuring element and provides a 3 to 15 psi output in addition to indicating viscosity. This air signal permits the use of all types of pneumatic control and makes it possible to use the viscometers with any pneumatic receivers/controllers. Also by suitable transducers or converters, various electric receivers can be used with this device. **Norcross Corp.**, Dept. N69, 247 Newtonville Ave., Newton 58, Mass.

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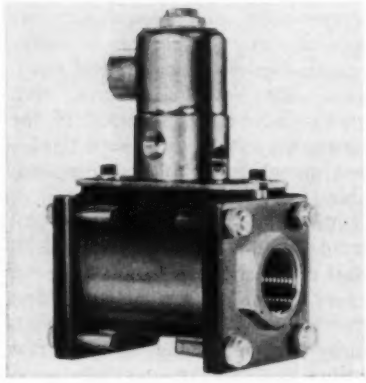

Pneumatic Valve

Valve's squeeze action automatically controls the flow of air, oil, chemicals, and grinding slurries,

The Bellows Air Motor®
Makes Pneumatic Circuits
Easier to Design • Easier to Build

The Bellows Air Motor makes designing for air operation a lot easier and less costly. Its built-in directional valve, built-in speed controls, and its single air connection (which can be flexible hose) is true space-saving design—makes it fit perfectly in cramped quarters or on moving machine elements. And from the standpoint of final design, the Bellows Air Motor offers faster action, more positive control, and minimum maintenance.

The Bellows Air Motor is available in various mounting styles, in five bore sizes (1¼", 1¾", 2½", 3⅝" and 4½"), and in any stroke length. Optional built-in valves include 8-12v low voltage control, 115v JIC electric control, manual or pneumatic controls, thus giving the design engineer the widest latitude in control systems.

Full data on Bellows Air Motors is in Bulletin BM-25, free on request. Write Dept. AU-361, Bellows-Valvair, Akron 9, Ohio.

Bellows-Valvair
AKRON 9, OHIO
DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

996-C

Circle 700 on Page 35

without the use of poppets or spools. There are no metal to metal contacts and no metal to rubber seals. Maintenance-free construction makes the Tube-O-Matic valve particularly suitable for the petroleum, chemical, and nuclear industries where contaminated fluids and gases present a problem. Pressures up to 200 psi can be handled by valve which is available either normally open or normally closed. Pipe sizes can range from ¼ to 12 inches. **Airmatic Valve Inc.**, 7313 Associate Ave., Cleveland 9, Ohio.

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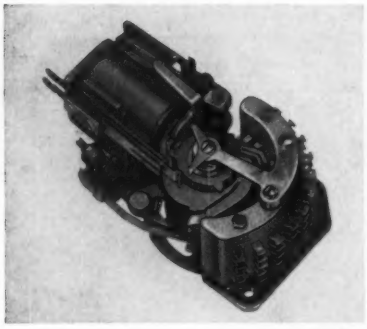

Rotary Stepping Switch

Switch was developed to fill the need for a truly decimal switch (10 points per wiper cycle) so that no extra steps must be taken, or off-normal points skipped. It provides up to 30 contacts per cycle and is available with from 1 to 5 bank levels of 10 contacts each. Type 40 rotary stepping switch operates by indirect drive, stepping when the coil is de-energized. Stepping is accomplished either from external impulses, or the switch may be driven self-interruptedly, or both. Coils are available for any dc supply up to 110 v. Standard voltages are 6, 12, 24, 48, 60, and 110 v dc. Rectified 115 v ac may also be accommodated. Switch features especially high dielectric molded banks. It is also available with taper tab terminals and in hermetically sealed enclosures. Precious metal (gold) contacting of wipers, brushes, and banks is available and should be used in low level switching. **Automatic Electric Sales Co., Subsidiary, General Telephone & Electronics Corp.**, Northlake, Ill.

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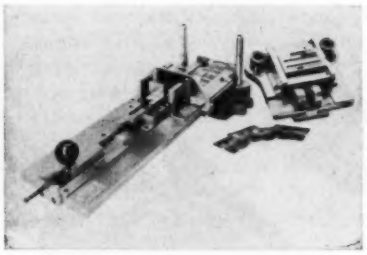
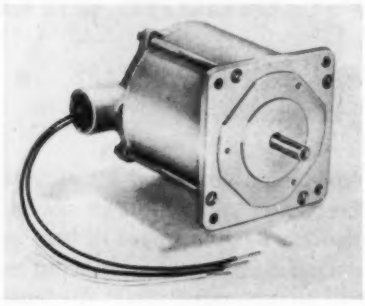


Name-Plate Stamping Unit

Name-plate feeding and stamping unit takes name plates up to 4 by 4 inches (larger by special construction). It can be used in standard types of punch presses that are constructed with open backs. Illustrated is the semiautomatic name-plate feeding and stamping assembly removed from the press and opened for inspection of component parts. The manually operated feeder may be power operated by addition of an air cylinder and properly interlocked controls. The name-plate magazine is adjustable to accommodate plates from ¾ by 2 inches up to 4 by 4 inches. **Acromark Co.**, 492 Morrell St., Elizabeth, N. J.

Circle 441 on Page 35



Explosionproof Motor

Synchronous motor, designated Slo-Syn Type X250, is used to provide safe operation in hazardous areas where a small arc or spark could cause an explosion. It will withstand internal gas and vapor explosions and is designed to prevent the ignition of surrounding external gas and vapor by internal spark, flash, or explosion. If desired, one revolution of the motor shaft can be converted into 200 precise steps by applying dc voltage to field windings. Ratings are: Input 120 v, 40/70 cycles, single phase; 0.6 ampere maximum current (at 60 cycles); 72 rpm output speed at 60 cycles; 250 oz-in. torque. Planetary gear type X250-Pl is available for applications which require a torque of 650 oz-in. and a speed of 16.6 rpm. **Superior Electric Co.**, Dept. SS, Bristol, Conn.

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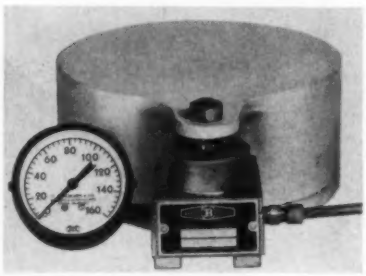
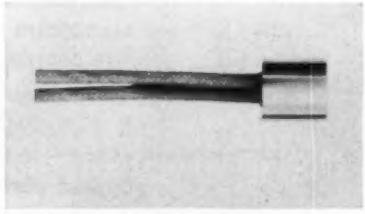


Pneumatic Mount

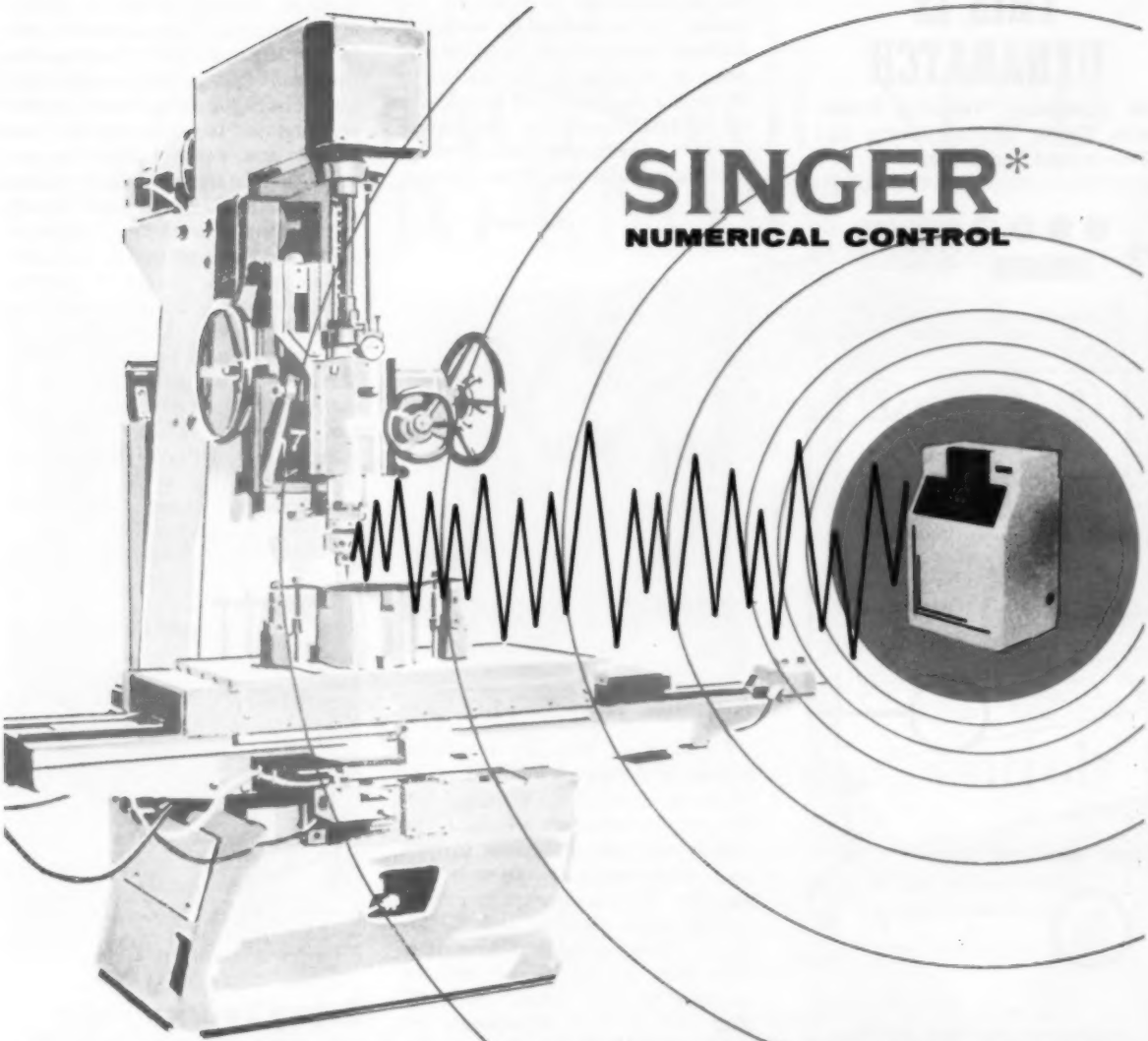
For use under the supporting points of high-precision machine tools, pneumatic mount is designed to support loads up to 30,000 lb per mount while isolating the machine from floor borne vibration on a column of air. It operates from standard factory air pressure (85-100 psi), and requires no special foundation. A dirt-air filter is the only accessory required. Mounting system automatically maintains level better than 2 seconds of arc or 50 millionths inch per foot. Repeatable accuracy is better than 0.1 per cent. **Barry Wright Corp.**, 700 Pleasant St., Watertown 72, Mass.

Circle 443 on Page 35



Temperature Detector

Miniature tip-sensitive temperature detector is designed to be mounted in the bearings of machinery. It is so small that it can be used in many places where larger temperature measuring instruments would not fit. Model 327 is ¼ inch long by 0.278 inch in diameter. It



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OF TRAVEL, ACCURACY OF .001

SINGER Numerical Control makes possible a high degree of accuracy by a division of the measuring section and the motor drive within the system.

The SINGER System also features *modular design*, making it possible to assemble basic units in a variety of control systems.

And, of prime importance, all modules and motors are designed, serviced and built by Diehl Manufacturing Company, a SINGER subsidiary.

To see SINGER Numerical Control in action, visit the unique demonstration room at the Diehl Plant near Somerville, New Jersey. Here you can examine actual production records as evidence of the economy, reliability and accuracy of this advanced point-to-point positioning system. Call or write for an appointment at the address below.

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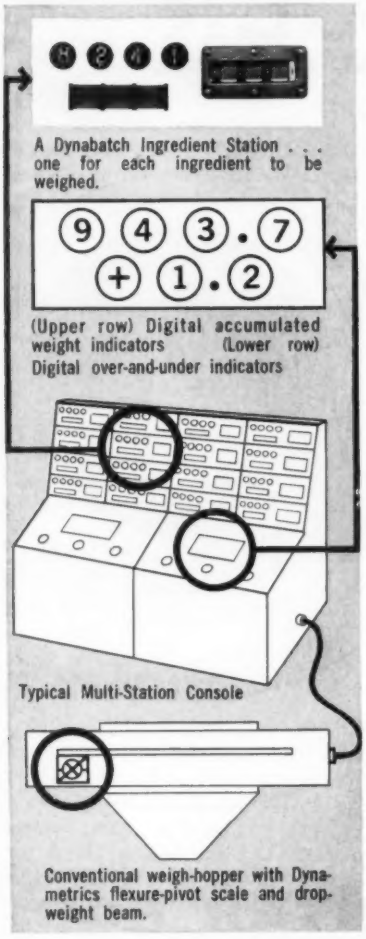
an Automatic Weighing System with Direct Digital Setting and True-weight Indication


A Dynabatch Ingredient Station . . . one for each ingredient to be weighed.
9 4 3 . 7
+ 1 . 2
(Upper row) Digital accumulated weight indicators (Lower row) Digital over-and-under indicators
Typical Multi-Station Console
Conventional weigh-hopper with Dynametrics flexure-pivot scale and drop-weight beam.

- Direct digital setting and true-weight indications
- Accepts digital inputs from card-readers without analog conversion
- Completely self-checking
- Modulated feeder controls
- Exclusive Dynametrics flexure scales throughout
- All major components plug in

Dynametrics manufactures a complete line of automatic weighing equipment. Write for Catalog 200, an illustrated 20-page handbook on automatic weighing.

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Circle 702 on Page 35

can be connected to indicators, recorders, or controllers by means of ordinary copper wire. Sensing element or winding of the detector is located in the first 0.060 inch of the tip for fast response to temperature changes. **Instrument Div., Thomas A. Edison Industries,** West Orange, N. J.

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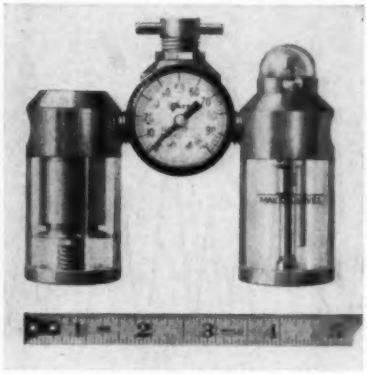

Air Line Lubricator

Compact air line filter-regulator-lubricator is designed for applications where space is limited or where low flow requirements are a factor. The unit is available in ⅛ and ¼-inch sizes, with maximum pressure 150 psi. The filter features a 20 micron porous bronze element, and the lubricator provides lubrication at flow rates from 0.2 to 15 cfm without excessive pressure drop. Both fill plug and oil feed adjustments are interchangeable front to rear. **Industrial Div., Watts Regulator Co.,** Lawrence, Mass.

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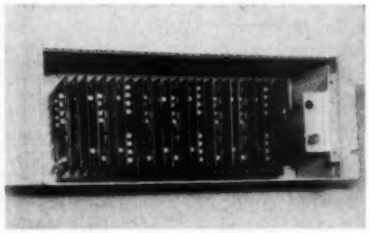

Digital Subtractor

Transistorized digital subtractor is designed to determine the arithmetical difference between two inputs. Either or both inputs may be contact closures or voltage levels in decimal, natural binary, or binary coded decimal. The numerical difference between the inputs is expressed as voltage level outputs suitable for driving lamp banks or mercury relays. In addition, the subtractor produces a separate output signal indicating the polarity (sign) of the difference when the inputs have been arbitrarily designated subtrahend and minuend. Available as an optional feature is another independent signal generated for zero difference. The subtraction process is parallel except for carries. Maximum propagation time of all carries is 50 microseconds per decimal digit (4 bits). By rearrangement of the internal logic functions, the subtractor may be used as a digital adder. **Datex Corp.,** 1307 S. Myrtle Ave., Monrovia, Calif.

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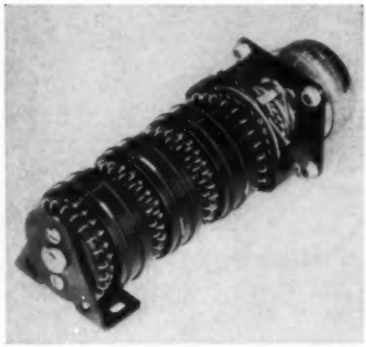

Rotary Switch

Type RSA rotary switch contacts, rated at 10 million operations each at 100 ma current, are gold plated for low contact resistance and sealed in nitrogen for insurance against corrosion. They will interrupt up to 500 ma, 115 v ac with a decrease in rated life. Each contact is double ended so that circuits requiring isolated contacts in a switch configuration are feasible. This allows, in many applications, the use of fewer decks to accomplish a job. Because of high natural frequency, cantilever type contact bars, the switch is resistant to external vibrations in the range of 10 to 2000 cps. Vibration levels to 35g in this range do not cause erratic contact closure on open contacts or contact noise on closed contacts. Each deck of the rotary switch has 24 positions, and can

have 1, 2, 3, 4, or 6 poles. Each section (single pole, 24 position—double pole, 12 position, etc.) can have independent contacts or a standard common contact as desired. Other contact configurations and ratings are available. **Hathaway Instruments Inc.**, 5800 E. Jewell Ave., Denver 22, Colo.

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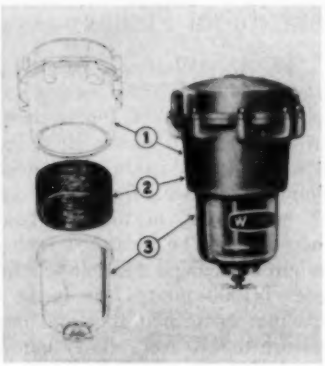

Compressed Air Filter

Newly designed compressed air filter offers low pressure drop, 5 micron filtration, high air flow, and full sump capacity. The bowl is available in either transparent plastic or metal for air pressures up to 250 psi and temperatures up to 250 F. Designated as Pure-Flo, this filter is available in pipe thread sizes from $\frac{1}{4}$ to 5 inches, for flows of air from 16 to 3100 cfm at 100 psi. **Wilkerson Corp.**, 1552 W. Girard Ave., Englewood, Colo.

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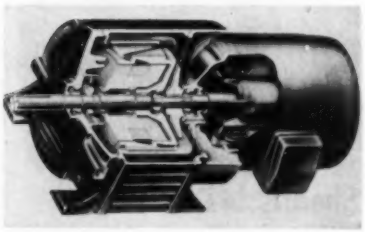

Adjustable Speed Drive

Eddy-current coupling, packaged, adjustable speed drive operates directly from standard industrial ac power lines. A standard package includes a drive unit control enclosure (Type 1, 2, or 3) and operator's station. A wide variety of control functions such as

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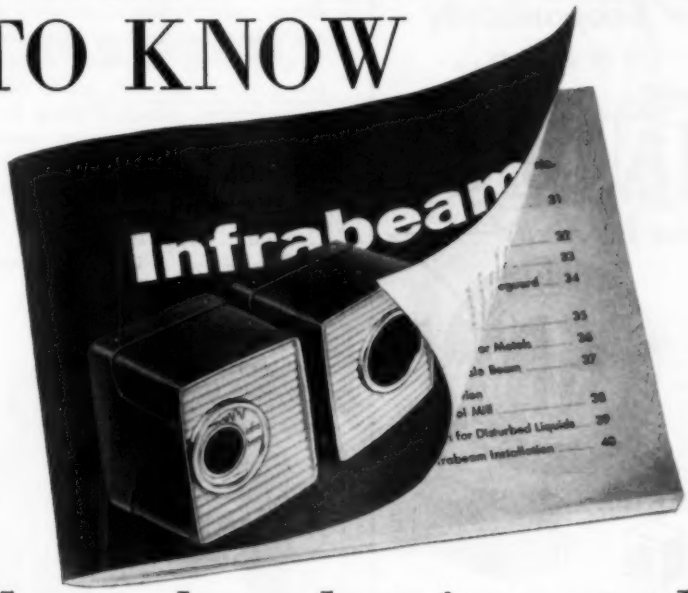

about photoelectric controls

Here, in a compact, idea-sparking handbook, is proof that photoelectric controls *can* work — reliably, without fussy engineering, and at long range. They're being used profitably *now*, for machine control, door automation, area surveillance, conveyor control, materials handling, remote control of liquid levels, and countless other applications.

Forty case histories show you graphically how others use Infrabeam to solve tough problems like these:

- Protecting a 1,000 foot fence
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- Preventing damage to machines and operators
- Avoiding wasteful process operation
- Automatically controlling a distribution conveyor

Infrabeam is a totally new type of photoelectric control. It uses *infrared* radiation, *not* visible light, for superior reliability at long range and under difficult light conditions. The beam is *modulated*, to prevent actuation by strong sunlight or incandescent lamps.

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Infrabeam *the practical man's photoelectric control*

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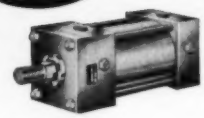
How to use
FLUID POWER
✓ efficiently
✓ economically
is as easy as . . .

when you specify

PROVEN QUALITY
SP
CYLINDERS • BOOSTERS

SERIES A



Standard Cylinders
AIR or OIL
Without Modification

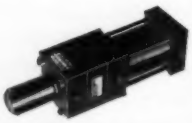
Save money with S-P's complete line; rated 200 psi air, 500 psi oil or water; 23 mounting types; 11 bore sizes—1½" thru 14"; see Catalog 110C.

SERIES B

HIGH PRESSURE
Hydraulic Cylinders

Get smoother, more precise power; ruggedly built, interchangeable; 2000 psi (3000 psi non-shock); 12 bore sizes—1⅛" thru 12"; get Catalog 117.

SERIES C



Air-Oil BOOSTERS

Save money, save space; boost 80 psi line air to 3000 psi hydraulic power with no added power consumption, no maintenance; see Catalog 116.

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A-3883A

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A BASSETT COMPANY
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jog, thread, or brake are available as modifications. The drive is controlled from the operator's station which includes pushbuttons and a speed setting dial. Applications include uses on such equipment as: Single-motor conveyors, large crane hoists, rotary filters, winders and rewinders, corrugators, printer-slotters, spoolers, annealers, capstans, job presses, extruders, small rolling mills, feeders, grinders, metal working presses, and water pumps. Drive is available in ratings from 5 through 100 hp. **General Electric Co.**, Direct Current Motor and Generator Dept., Erie, Pa.

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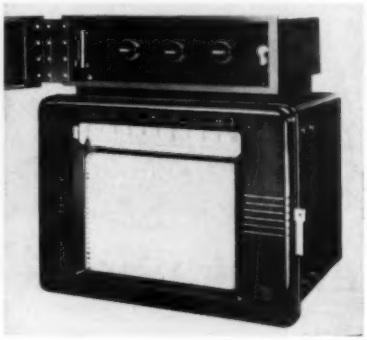

Zero Recorder

Automatic extended range recording device has capabilities of measuring unknown and widely varying levels of potential. Having from 2 to 5 automatic steps of zero suppression, the zero is automatically shifted to accommodate any signal within a specified range. As the variable exceeds or goes below the span, the scale is extended or contracted. Zero suppression does not affect the recorder's span. Any span from 2 to 250 mv may be selected. A total span of 500 mv is maximum. Instrument has an accuracy of ¼ of 1 per cent of entire span and a sensitivity of 1/10 of 1 per cent of each span. Zener diode constant voltage source is standard. It holds the guaranteed accuracy even in the one mv span. Only three adjustments have to be made: The calibrated span vernier, the calibrated zero vernier, and an arbitrary amplifier gain control. **Wheelco Industrial Instruments Div., Barber-Colman Co.**, Rockford, Ill.

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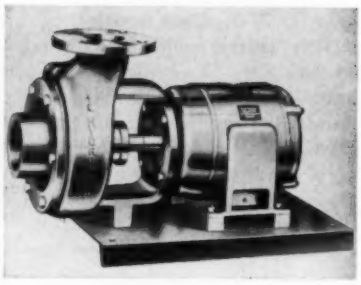

Centrifugal Pumps

Line of industrial centrifugal pumps is offered in two models with 3 sizes in each model. These pumps can be furnished either close coupled to electric motor or pedestal mounted for user coupling to electric motor, gas, or diesel engines. They can also be furnished both as straight centrifugal and self-priming. Series N1000 pumps are made in capacities up to 550 gpm and head pressure to 170 feet. They can be furnished in cast iron bronze fitted or in all bronze. Other materials are also available. **Hydropump Inc.**, 165 S. Fair Oaks Ave., Pasadena, Calif.

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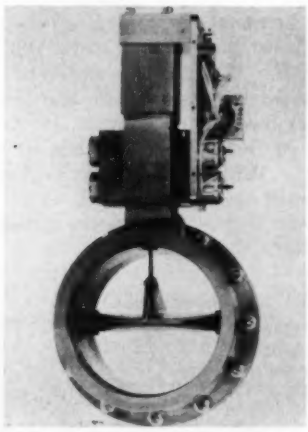

Shearable Disc Valve

Hermetically sealed shearable disc valve is available in a range of sizes. It is ideal for various critical fluid storage applications in industry, and can be obtained in either butterfly or poppet designs. This valve has a nonageing metallic disc that provides zero leakage indefinitely in the presheared condition. Actuation is rapid either by pneumatic, hydraulic, or pressure

cartridge (squib) action. Upon reclosure, after shearing, leakage is exceptionally low. **B. H. Hadley Inc.**, 1427 S. Garey Ave., Pomona, Calif.

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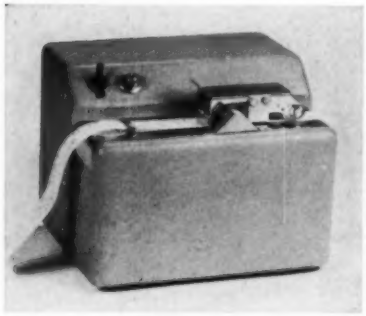

Paper Tape Reader

Small paper tape reader, designated Raeden and capable of reading 30 characters per second, has been developed for input to tape to card converter, typewriter, digital to analog converter, data processing systems, digital computers, controls for automating machine tools, direct telephone line transmission of data, and many other system uses. It can read 5, 6, 7, or 8 channels via bifurcated contacts operated by star wheels. **Systronics**, 3673 Newton St., Torrance, Calif.

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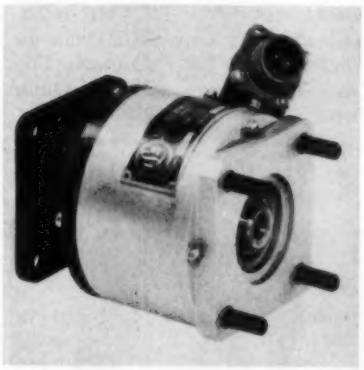

Magnetic Pickup

High-speed magnetic pickup permits accurate measurement of rpm. Designed for mounting between a tachometer generator and an AND 20005 engine mounting pad, Model 2043 can deliver high-level signals to operate remote frequency count-

PRECISE CONTROL of speed

and/or position

with SENECA FALLS systems & components

If you have a control problem of *any* magnitude please find out what Seneca Falls has done and is doing in the field of control and automation techniques.

We offer complete systems from fractional to integral horsepower for control of speed, position, instruments, machines and processes.

We can supply control components . . . sensing devices, tape controls, power and synchronized drives, *and* the mechanical assemblies to be controlled.

Seneca Falls systems are equally suitable for the conversion of existing equipment or the control of new equipment.

If you want design sophistication combined with operating simplicity, call on Seneca Falls.

Write for Bulletin EE 1008. We will also send you our Design Requirements form which will assist you in defining your control problem.

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PIONEERS IN AUTOMATION

SENECA FALLS, MACHINE CO.
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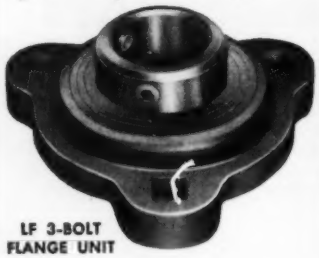
SEALMASTER

"L" SERIES

A HIGH QUALITY LINE OF MALLEABLE HOUSED BEARING UNITS AND BEARINGS AT A COST THAT IS WARRANTED ON YOUR MACHINE!

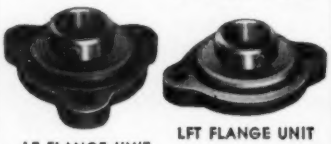
ECONOMY PERFORMANCE QUALITY



LF 3-BOLT FLANGE UNIT

Available in pillow blocks and two or three bolt flange units for flush or recessed mounting. All units in the "L" Series available with the new SEALMASTER contact type seal.

LP PILLOW BLOCK



LF FLANGE UNIT LFT FLANGE UNIT

WRITE FOR BULLETIN 359

SEALMASTER®

BALL BEARING UNITS

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A DIVISION OF
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22 RIDGEWAY • AURORA, ILL.
PLANTS LOCATED IN: LOS ANGELES, CALIF. CLARKSDALE, MISS. • BELLEVILLE, ONTARIO

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ers or recording instruments, located in some installations up to 500 feet away. Precision instrument-type sealed bearings permit operation at speeds up to 10,000 rpm. Standard operating frequencies are 60 or 120 pulses per revolution. Special rotor-stator assemblies with frequencies ranging from 1-240 cycles per revolution are available. The pickup features a rear mounting flange which accommodates a standard AN 5544-3 engine tachometer generator or a suitable ac or dc generator to provide a signal concurrent with the digital information. **ILS Electronic Div., Meriam Instrument Co.,** 10920 Madison Ave., Cleveland 2, Ohio.

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Computing Components

Solid state analog computing components may be combined to perform a variety of laboratory and engineering functions. The TR-5 component mounting unit makes it possible for special purpose analog computers to be assembled easily. The components are plugged into the mounting unit where they may be interconnected according to the computing function to be performed. The TR-5 mounting unit contains all the controls necessary to operate a 20-amplifier computer. The basic unit will house up to six computing components and a fully-transistorized power supply. It may be expanded to large-computer capability by adding up to two expansion units to the basic rack. The TR-5-1 expansion unit is prewired to accept an additional five dual transistorized amplifiers. The other expansion unit, the TR-5-2 provides space for 10 dual modules or 20 single modules which can be wired to accept any of the computing components. Both expansion units are powered from the power supply located in the basic TR-5 mounting unit. **Electronic Associates Inc.,** Long Branch, N. J.

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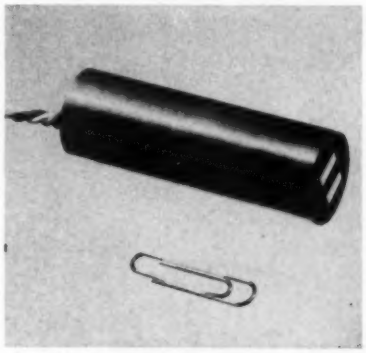


Proximity Switch

Switching device is ideally suited for such applications as machine beds and ways, air and hydraulic cylinder ends, checking devices, and rotating cam timers. It may be installed on die faces to distinguish between one and multiple sheet thicknesses. The unit is snap-acting, with repeatability within 0.001 inch. Differential between *On* and *Off* position is approximately 0.008 inch. Coil spring loaded, the switch maintains high constant pressure and cannot dwell between *On* and *Off* position. Contacts are rated at 6 amps current at 110 volts resistive load and 3 amps at 220 volts for nominal life. **Tann Controls Co., Div., Tann Corp.,** 3750 E. Outer Drive, Detroit 34, Mich.

Circle 456 on Page 35

Photoelectric Transducer

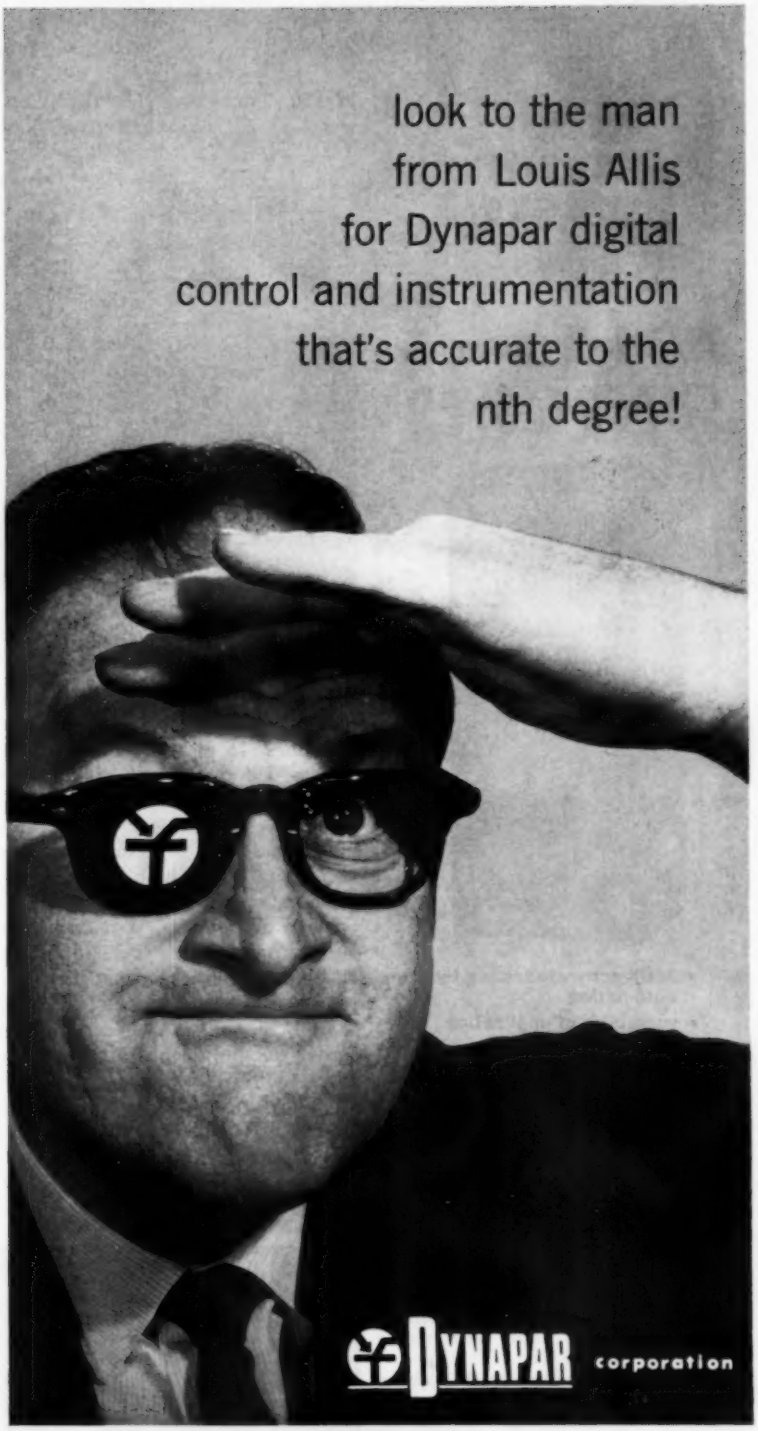
Transducer operates on principle of interruption of a light beam by a slotted disk and has been developed for incrementally converting shaft angle to digital measurement

information. Applications include use as analog to digital shaft converter, precision analog servo with digital readout, data reduction equipment, tachometers, and precise measurement and control. Maximum permissible speed of the device varies from 15,000 rpm at 128 counts per revolution to 1250 rpm at 2048 counts. It provides sampling rate up to 45,000 counts per second. Unit is designed for a life of 5 years at the recommended power levels—for lamps, 5 v dc at 0.33 amp each and for photo transducers, 12 v at 1 ma each. A separate gating unit is available with 9 v pulse output. Recommended maximum operating temperature is 55 C. Rate information may be taken simultaneously with quantity, and electrical zero reset is available. **Electronics Div., Hydro-Aire Co.**, 3000 Winona Ave., Burbank, Calif.

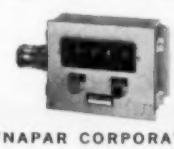
Circle 457 on Page 35

Solenoid Valves

Cooler and quieter operation are features of Type 303 2 and 3-way solenoid valves. Valves are available in normally open, or normally closed types, ¼ or ⅛-inch pipe sizes, ac or dc, conduit or grommet housings. Time delay, metering (bottom, 45 degrees, side or pipe connector), free venting, and 3-way directional valves are also available. Standard valves can handle vegetable and light oils, gasoline, inert gases, air, and water at temperatures up to 185 F. Special inserts can be furnished for corrosive and other media. Coils



Dynapar is the electronic subsidiary of The Louis Allis Co., Milwaukee 1, Wis. We make a full line of transistorized digital counting, measuring, and control devices. Information on any of these products can be obtained from your local Louis Allis District Office — which is listed in The Yellow Pages under "Electric Motors."


Draw Indicators

Process Controllers

Rotopulsers

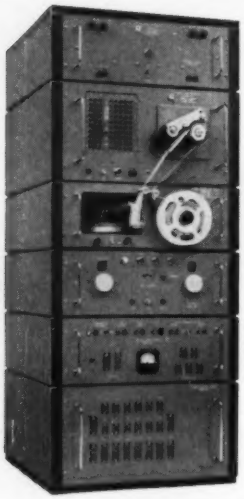
DD-222

DYNAPAR CORPORATION, 7312 N. RIDGEWAY AVENUE, SKOKIE, ILLINOIS

Circle 707 on Page 35

REDUCE TESTING COSTS

CTI Tape-Programmed
SUPERTESTER®



- 100% accurate testing by automation
- versatility of application
- simple programming
- 8 years proven reliability

Why does the CTI Supertester lead the field? Because this equipment will save 90% of your testing costs. Its outstanding features have made CTI testing equipment sought by the nation's leading industries: high accuracy go/no-go bridge measurements, the widest scope of tests and auxiliary operations, and complete customer confidence gained through fail-safe circuitry and self-testing ability. Automate your electronic testing operations. The CTI Tape-Programmed Supertesters, Models 180 or 210 can strengthen your testing practices and improve your competitive position.

WRITE FOR FULL INFORMATION
Foremost in Automatic Testing

CTI® CALIFORNIA TECHNICAL INDUSTRIES
DIVISION OF TEXTRON INC.
BELMONT 6, CALIFORNIA

Circle 708 on Page 35

with Class A, B, or H insulation are available, rated for maximum ambient temperatures of 105, 130, or 180 C respectively. **Allied Control Co. Inc.**, 2 E. End Ave., New York 21, N. Y.

Circle 458 on Page 35

Production Rate Recorder

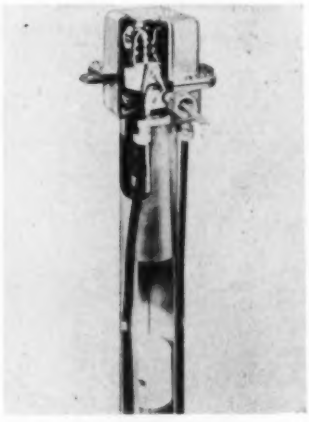
Instrument is designed to analyze production rate of key automatic machines. It plots a complete log of production rate information for any machine directly on graph paper and automatically integrates production data, constantly comparing actual rate with a predetermined standard reference rate. Percentage of deviation is recorded on a graph. Unit operates on 115 volts, 60 cycles. It provides convenient selection for such periods of 1, 2, 4, 8, and 16 hours. A time speed recorder can be used as a companion instrument. This device monitors automated operations to split-second accuracy. **R. B. Annis Co.**, 1101 N. Delaware St., Indianapolis 2, Ind.

Circle 459 on Page 35

Air Switch

Magnet-actuated miniature air switch only 1½ inches long and ½ inch in diameter weighs less than 2 ounces. Designed especially for use in pneumatic circuits where a low actuating force is available, the switch has no mechanical linkage or striking parts. It can be used in place of electrical components such as limit switches, pressure switches, solenoid valves, and other devices in ordinary service or in areas where there is an explosion hazard. Features include snap action when energized or de-energized by a small magnet on a moving member of a mechanism, low air consumption, and maximum pressure of 25 psig. Bleed rate is 0.05 scfm at 10 psig when de-energized, and zero when energized. **Associated Control Equipment Inc.**, P. O. Box 136, Coraopolis, Pa.

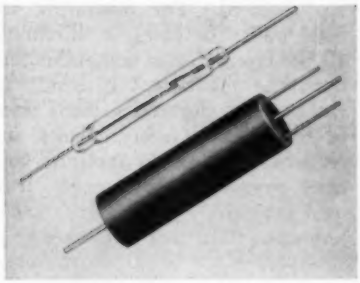
Circle 460 on Page 35



Liquid Level Control

Winter-proofed Model A-101 liquid level control has been developed to protect outdoor water tanks against freezing. It is unaffected by the heaviest collection of humid atmosphere or by complete immersion of the head itself. Inside, a mercury switch assembly is protected against freezing weather by its vapor-proof construction, which prevents the entrance of atmospheric moisture (with consequent frost buildup), and by a resistance heater which keeps the housing interior warm. Displacers are set to maintain a constant 36-inch differential between pump start and stop. Maximum differential can be shortened in 6-inch increments. **Magnetrol Inc.**, 2110 S. Marshall Blvd., Chicago 23, Ill.

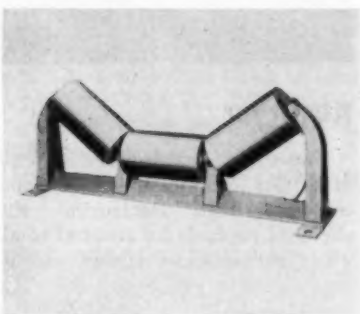
Circle 461 on Page 35



Reed Relay

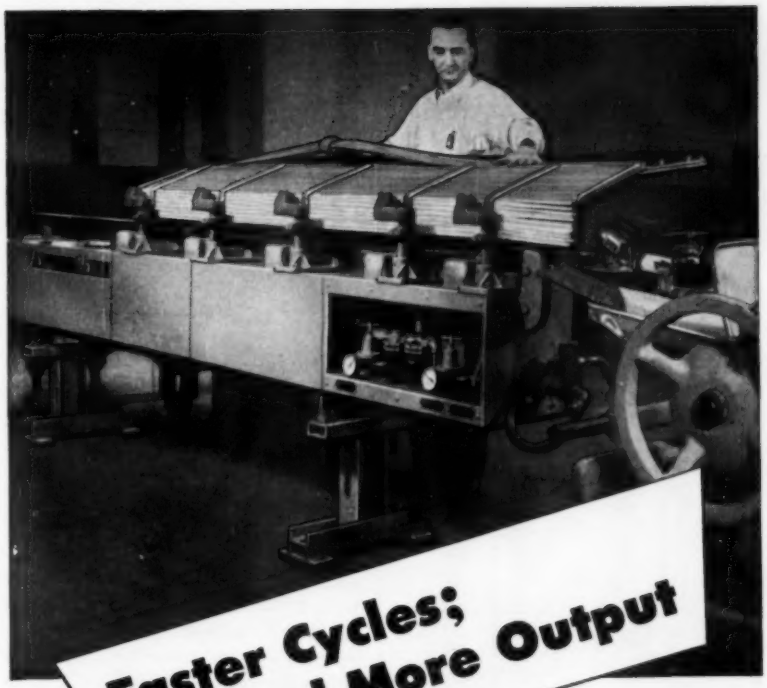
Unit incorporates a short pole piece with a longer moving reed which permits high operating speeds. It provides improved dependability and performance for computers, data processing equipment, transistor drive, and other applications. A hermetically sealed, glass encapsulated magnetic reed switch, surrounded by an operating coil to provide SPST normally-open relay action is well suited for low level switching or for lower power switching of loads up to 15 watts and 250 volts. Maximum operating current is 1 ampere. Load life at one-quarter of maximum rating is on the order of 200 million operations. Minimum operating power is approximately 100 milliwatts. **Struthers-Dunn Inc.**, Pitman, N. J.

Circle 462 on Page 35



Belt Conveyor Idlers

Line of belt conveyor idlers has been expanded to include 60 new 35-degree deep trough idlers and 24 additions to a line of 45-degree idlers. Such heavy materials as coal, sand, gravel, crushed stone, and certain crushed ores can be handled with the 35-degree idlers. The 45-degree idlers are primarily designed to handle lighter materials such as grain and wood chips,



with Less Fatigue and Higher Sustained Production

Machine speed – not worker efficiency – governs production on automatics equipped with Lipe Automatic Machine Loading Bar Feed. That's because Lipe takes over the tedious, back-breaking hand-loading – leaves the machinist free to concentrate on quality . . . machine set-ups . . . care of tools.

The LIPE AML Bar Feed

automatically and continuously feeds stock of practically any length, shape or material in close-tolerance feedouts. Users report production increases of 40% . . . 90% . . . even 200% per machine, plus labor benefits that are even more important. We'd be glad to give you a fair estimate of what Lipe can do for you. Just send prints of samples or some typical work.

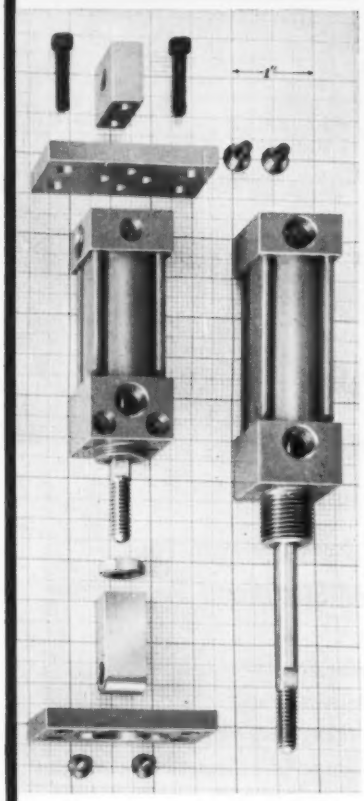
Stop Cutting Air and you Start Cutting Costs

Lipe-ROLLWAY CORPORATION SYRACUSE 1, N. Y.

PIONEERS IN PNEUMATIC BAR-FEEDING

Circle 709 on Page 35

HOW SMALL
do you want 'em?



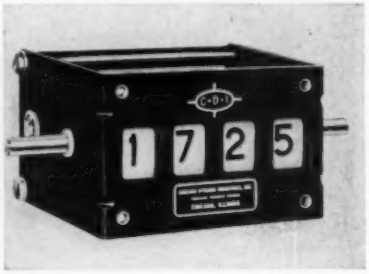
Hannifin offers new "Midget-Air" 200 psi cylinders in ¾", 1" and 1⅛" bores, double-acting or spring-return. Two basic models, "universal" and "nose-mounting." Universal models come drilled and tapped for mounting, or for use with any combination of the mounting attachments pictured. Delivery is off-shelf in standard strokes, shipment in ten days to specified stroke lengths. Want dimensions and prices? Write:

PARKER HANNIFIN CORPORATION
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS
HANNIFIN COMPANY
A DIVISION
541 South Wolf Road • Des Plaines, Illinois
EUROPEAN DIVISION • PARKER-HANNIFIN N.V.
SCHIPHOL • THE NETHERLANDS

Circle 710 on Page 35

but under certain conditions can be applied for heavier materials. **Link-Belt Co.**, Dept. PR, Prudential Plaza, Chicago 1, Ill.

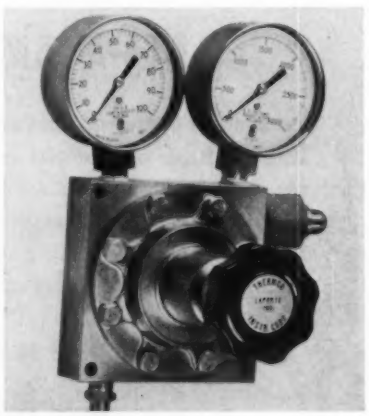
Circle 463 on Page 35



Mechanical Counter

Bidirectional counter with 7/16-inch high numerals is designed for such applications as ground support equipment, in-plant test and production equipment, machine automation, etc. Model CM-4-3000 has an anodized aluminum frame with an approximate ¾ inch width for each wheel. One to seven numerical wheels are available, each 2 inches in diameter by ½ inch wide. Operating speed of the device is 600 rpm continuous and operating torque approximately 1 oz. in. **Precision Products Div., Chicago Dynamic Industries Inc.**, 1725 Diversey Blvd., Chicago 14, Ill.

Circle 464 on Page 35



Pressure Regulator

Stainless steel pressure regulator has been designed for the precise sampling of compressed gas cylinders or other applications where low flows of uncontaminated gases are required. For measuring the total purity of gases, it eliminates all the errors due to contaminations from the regulator. It eliminates the necessity for costly bleed flows in total purity measurements and reduces the time in moisture and trace oxygen measurements. It is used extensively for moisture measurements. The stainless steel construction of the regulator makes it ideal for use with corrosive gases. It is also ideally suited for use in precise chromatography analysis where pure uncontaminated gases are required for the carrier gas. Inlet pressure of the instrument is 3000 psi maximum, and outlet pressure is 0-100 psi. Flow is 0-10 cfh. **Thermco Instrument Corp.**, Route 20, La Porte, Ind.

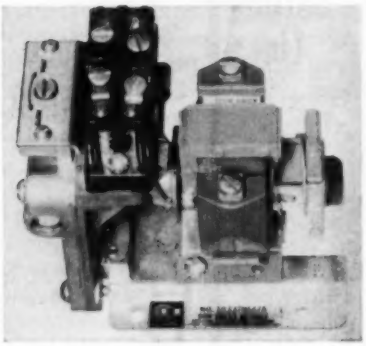
Circle 465 on Page 35

Air Dryer

Two-stage nonregenerative air dryer for compressed air systems combines both mechanical and chemical methods for removal of all water and moisture vapors, providing a dewpoint as low as −20F. The first stage utilizes a helical centrifugal chamber as a prefilter for the air stream, where all water and other particle contaminants are removed, leaving only the vapor content entering the desiccant (chemical) bed. This reduces the desiccant consumption. Unit employs General Beads desiccant, a polychemical base in small bead form which slowly dissolves during the process, requiring repetition only twice yearly. This dryer is available in 12 standard models, ranging up to 2250 cfm capacities. Standard working pres-

sures are 150 and 200 psi. Higher pressures, and greater capacities are also available. **General-Erie**, 1702 Peninsula Drive, Erie, Pa.

Circle 466 on Page 35



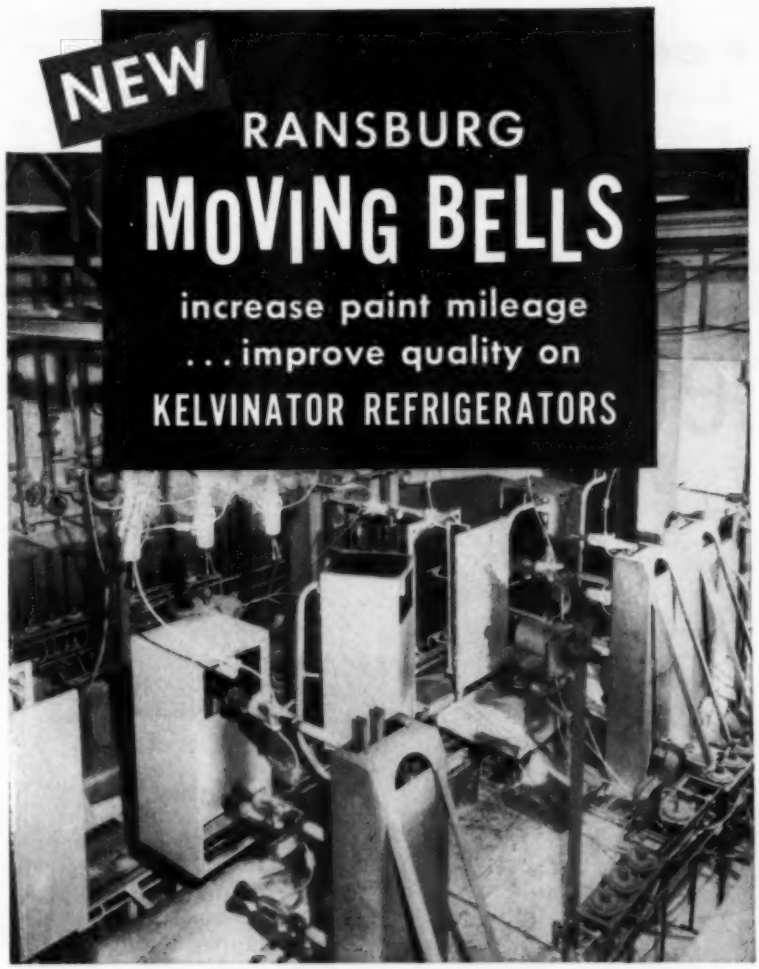
Timing Relay

One-minute pneumatic timing relay can be used in such applications as machine tool and sequence controls. Diaphragm assembly of the unit eliminates need for an exhaust valve. The timer's adjustment screw takes seven complete turns to insure positive, accurate adjustment over a range of from 0.2 to 60 seconds. Easily converted from on-delay to off-delay, the timer features unit construction, molded magnet coil, and a precision unit switch. The switch is suitable for pilot and control circuit duty to a maximum of 600 volts. The diaphragm is made of silicone rubber and will operate dependably in temperatures as high as 150 F or as low as −45 F. **Cutler-Hammer**, 378 N. 12th St., Milwaukee, Wis.

Circle 467 on Page 35

Rotary Limit Switch

Four circuit limit switch features four switches and four independently adjustable cams. Primary use is for machine tools, handling devices, and rotary operations where motion is expressed in shaft rotation. Each circuit has a single pole,



Ransburg's No. 2 Process moving bells—latest innovation in electrostatic painting—automatically paint mixed sizes of refrigerator cabinets and doors on Kelvinator's new finishing line.

On this job—first of its kind—limit switches re-position the reciprocating bells to accommodate various model sizes mixed on the same line. And, electric eyes selectively trigger the paint on and off between parts.

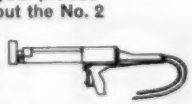
RESULTS? Automatic electrostatic spray painting—which replaced a battery of reciprocating automatic air guns—is providing Kelvinator with a beautiful, higher quality, and more uniform finish. Rejects, formerly a troublesome problem, have been practically eliminated. And, along with appreciable labor savings in this highly automated set-up, paint mileage is substantially improved . . . even bettering the savings indicated in pre-installation lab tests at Ransburg.

Like Kelvinator, other manufacturers of quality products will find Ransburg's moving bells the automation answer for production lines where batching of similar parts is impractical.

NO REASON WHY YOU CAN'T DO IT, TOO!

Want to know how Ransburg No. 2 Process can improve the quality of YOUR painted products—and at the same time—cut YOUR paint and labor costs? Write for our No. 2 Process brochure. Or, if your production doesn't justify automatic painting, let us tell you about the No. 2 Process Electrostatic Hand Gun which can be used in either conveyorized, or non-conveyorized painting.

RANSBURG



RANSBURG Electro-Coating Corp.

Box 23122, Indianapolis 23, Indiana

Circle 711 on Page 35

Feedall
hopper-loading,
parts orienting...
completely self-contained

automatic
feeders

feed
rolling or
sliding parts faster,
easier, at lower cost

Feedall machines are a perfect complement to your high-speed operations. They eliminate hand feed, assure uniform output and maintain a pre-set parts flow-rate. Moreover, they perform with multi-million cycle reliability, precisely controlled to fit your production needs in cost-saving operation.

Easily Installed. A Feedall forms an integrated, high-speed automatic unit when combined with a centerless grinder, milling machine, forging press, or similar machine. Placed next to the machine to be fed, the Feedall is ready to operate, proved in hundreds of installations. Write for details today.

Feedall
Designers and builders of automatic feeding devices

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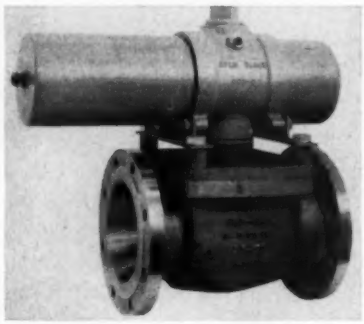
WILLOUGHBY, OHIO

Circle 712 on Page 35

double throw, switch with isolated contacts that are rated at 5 amperes, 115 and 250 v ac; and 3 amperes, 30 v dc. Cam arrangements from 25 to 335 degrees in approximately 20-degree steps are available along with 15 different gear ratios ranging from 5:1 to 1000:1. Other special ratios and cam arrangements are available on request. **Gemco Electric Co.**, 25685 W. Eight Mile Rd., Detroit 40, Mich.

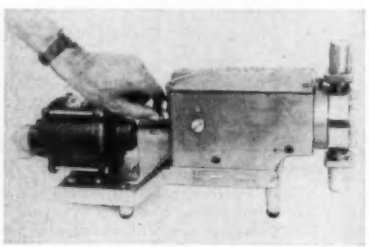
Circle 468 on Page 35



Fail-Safe Valve

High capacity, fail-safe industrial Flo-Ball valve is designed for applications in the pulp and paper, petroleum, pipeline, chemical, and process industries. Rated at 150 lb ASA, the 8-inch valve is equipped with a close coupled, air-operated actuator with a manual override. Designated as Model 731V, the valve is equipped with a spring return so that it can be set up to either open or close in case of air failure. **Hydromatics Inc.**, 5 Lawrence St., Bloomfield, N. J.

Circle 469 on Page 35



Liquid Metering Pump

Developed for accurate metering of chemicals in flow ranges up to 4240 cc per hour, Pulsafeeder Micro-

YODER Rotary Slitting Lines ... produce the strip widths you need!

Investigate the many advantages of YODER-engineered Slitter Installations. Write today for the comprehensive, 80 page YODER Slitter Manual ... it's yours for the asking!

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1910 **FIFTY YEARS** 1960

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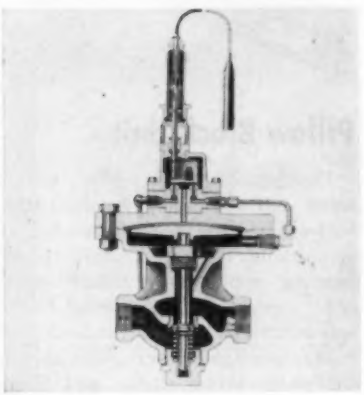
Circle 713 on Page 35

flow LS-5 handles highly corrosive as well as noncorrosive liquids. It can be utilized as a sampler, a proportioner, a filling machine, a chemical feeder, a pump, or as a means for fluid control by responding to instruments measuring process variables. Applications include the textile, pulp and paper, petroleum, gas, rubber, food, and pharmaceutical industries. This positive displacement type pump has a maximum theoretical capacity of 1.1 gph at 500 psig. Piston size is ½ inch. Unit is adaptable to all methods of semiautomatic and fully automatic pumping. Timers and program controllers attached to the pump drive provide intermittent flow control. **Process Equipment Div., Lapp Insulator Co. Inc.**, 122 Hall St., LeRoy, N. Y.

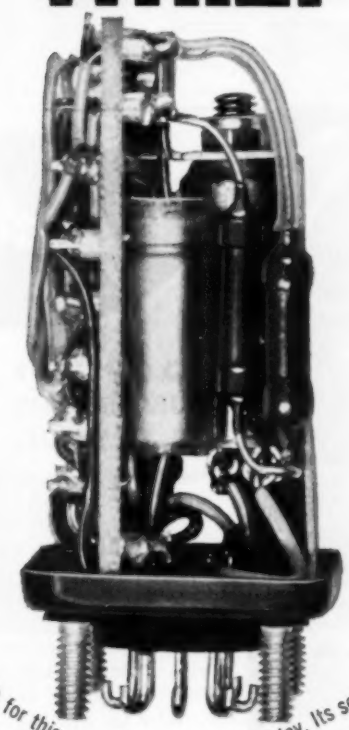
Circle 470 on Page 35



Temperature Regulators

Line of temperature regulators, designated Eventemp, are used in either continuous or standby service on storage heaters and coolers, process heaters and coolers, stand pipe heaters, cookers, ovens, lube oil storage heaters, and in other applications where it is desirable for heating or cooling to take place at a maximum rate until a set point is reached. Regulators are single seated, diaphragm actuated, self-contained units with a lever-type internal pilot. There are only two moving parts in the regulator body. Regulators have a pressurized, self-cleaning, friction-free Teflon stem seal and a tight closing, positive seating main valve. They are available with cast iron or bronze bodies, with screwed or flanged ends in a

50-G WHIZ!



RUGGED IS THE WORD for this A. W. Haydon time delay relay. Its sealed relay will withstand shock up to 50 g for 11 milliseconds, and vibration up to 2000 cps at 20 g. It is also precise... with delays up to 120 seconds before starting or stopping. This little giant is our Series 31300 electronic time delay relay and you ought to know about it, particularly if you're in the missile field. ■ Every favorable adjective in the book has been used by our customers to specify one or another of our electronic time delay relays. Fixed or variable delays from a few milliseconds to days, weeks or months. Our solid state switches resist up to 150 g shock, vibrations up to 3000 cps at 100 g... accuracies run to 0.05% or better. We could go on. But if you will simply write for information about the Series 31300 or any other timing devices you need, whether electronic or motor driven, we will be happy to tell all.

THE AWH HAYDON COMPANY

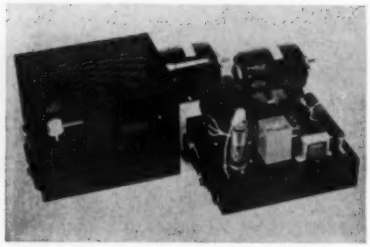
4069 INCE BLVD., CLUVER CITY, CALIFORNIA

Circle 714 on Page 35

complete range of sizes from ½ to 4 inches. Operating characteristics include inlet pressures up to 175 psi, and temperatures to 500F. **Leslie Co.**, 144B Delafield Ave., Lyndhurst, N. J.

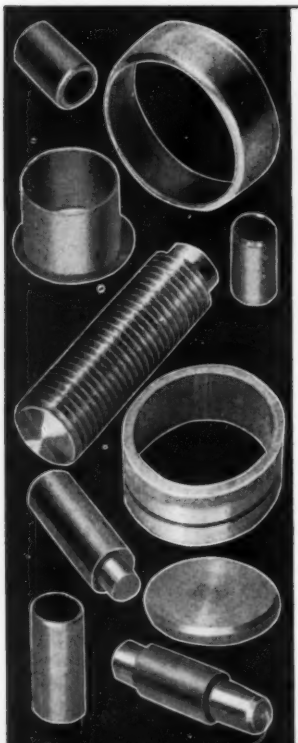
Circle 471 on Page 35

Twin Drives



Suitable for point-to-point or continuous table movement control, these twin drives are easily programmed and can automatically be impulsed to follow an unlimited number of input signals to change speed or mode of operation. The drives can be provided to receive commands manually, mechanically, electrically, or electronically. Inputs from punch tape controls can be easily accommodated. The drives are available with ratings from 1/40 to 3 hp. Z-axis and rotational axis companion drives are also available. Control system components for manual or automatic line following, and grid position control are available with line deviation accuracies from ±0.015 to ±0.001 inch. **ECI Manufacturing Div., Electronic Controls Inc.**, 85 Magee Ave., Stamford, Conn.

Circle 472 on Page 35



the Modern Way

TO CUT OFF AND FORM TUBING AND BAR STOCK *IN A SINGLE OPERATION*

Here is a combination that feeds tubing and bar stock — automatically — to a fast, automatic cutting-off machine. Best of all, the pieces being cut off can be formed, grooved, flanged or chamfered at the same time.

There are models that handle tubing, pipe and bar stock from ⅛" diameter up to solid bar stock of 3" OD and tubing up to 8" OD.

Why not investigate?

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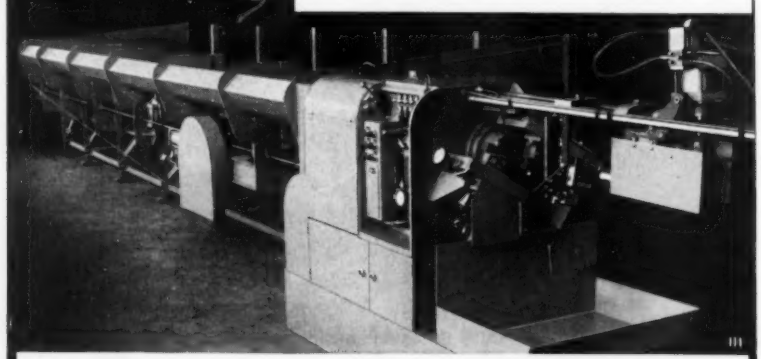
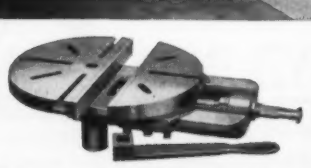
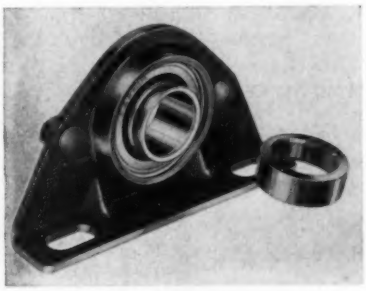
MODERN MACHINE TOOL CO.
2005 Losey St. • Jackson, Michigan





FREE TRIAL OFFER. Safe, positive, fast set-ups. The Modern Safety Drill Table handles odd, irregular shapes without V-blocks, clamps or parallels. Ideal for maintenance work. Guaranteed to save its cost in labor alone every 6 months. Sizes from 8" to 27½" dia. Try it at our expense. No obligation.



Pillow Block Unit

Designated PBS, this pillow block unit accommodates shaft sizes between ½ and 1 7/16 inches. It is suitable for most pillow block bearing applications where moderate speeds, moderate radial loads, and relatively light thrust loads are encountered as in fans, idler shafts, conveyors, pump shafts, and other lightly loaded power shafts. Design feature of the unit is the use of standard rubber contact seal bearings with self-locking collars. **Fafnir Bearing Co.**, 37 Booth St., New Britain, Conn.

Circle 473 on Page 35

Digital Display

Unit is designed for visual communication and operations control with fully automatic, semiautomatic, or manually operated equipment. It is possible to display words such as machine, ready, start, operation, etc., or any other combination of words desired by a user. In addition, red, orange, yellow, green, or blue colors may be displayed on the screen, either by themselves or as background for the word messages.

DISCONNECTS

Exploring new Horizons

PURIFIED AIR

Full line flow into "Y" socket. Metering orifices in socket permits supplying required air for one to six outlets.

LIQUID OXYGEN

Double shut-off type with modified bayonet locking. Metal to metal seals operating against 75 PSI, minus 310°F. Meets A. F. specs.

MINIATURE COUPLING

Weighing only 1/4 oz. with 7/16" OD and 1-1/8" OAL, this aluminum coupling designed for 1/8" tubing connections to missile motor. Easy Pulomatic ball detent locking action.

COMB. OXYGEN & ELECTRICAL

Connects oxygen and communications wiring to pressurized flying suits, survival kits and capsules. Seal engages and disengages before electrical contacts.

FUEL CHARGING

Straight-thru type with fast Pulomatic ball detent locking. Unique design permits high pressures, light weight construction and flush mounting.

REQUEST CATALOG 1200

P.S.C. offers you custom design service. We invite your envelope specification requirements.

where *Good Connections* count!

PERFECTING SERVICE CO.

332 Atando Ave. Charlotte, North Carolina

Baltimore · Buffalo · Chicago · Cleveland · Camden · Los Angeles
New York · Providence · Montreal · Toronto · Hamilton, Canada

Circle 716 on Page 35

Series 80000 digital display contains a master condensing lens with 12 individual positions or lenses and is available in single units or in assemblies. **Industrial Electronic Engineers Inc.**, 5528 Vineland Ave., North Hollywood, Calif.

Circle 474 on Page 35

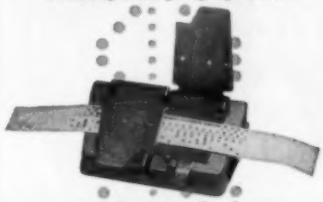
Pressure Transducer

Miniature size and compact configuration permit use of this gage pressure transducer wherever space is at a premium. It incorporates a Bourdon tube as a pressure sensing element. Bourdon tube materials available include beryllium copper for use with noncorrosive media, stainless steel for use with corrosive media, and Ni-Span-C for low temperature error applications. Model 304 specifications are as follows: Static error band (includes linearity, friction, hysteresis, resolution and repeatability): as low as ±1.5 per cent; power rating: 0.5 watt at 160 F; operating temperature range: −65 to +212 F. **Instrument Div., Bourns Inc.**, 6135 Magnolia Ave., Riverside, Calif.

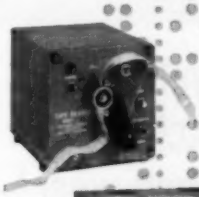
Circle 475 on Page 35

Punched Paper Tape Accessories

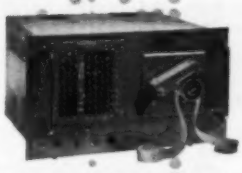
A complete line of quality punched tape processing components . . . adaptable to all systems.



TAPE SPLICER NO. 219
Edits, Mends, Corrects.

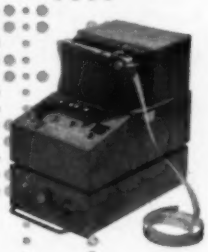


SINGLE LINE TAPE READER NO. 220
Reads up to 60 lines per second. 5, 6, 7 or 8 hole tapes.

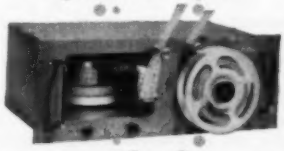


TAPE-ARD READER NO. 171
Reads 80 bits of information simultaneously.

Manual TAPE-ARD PUNCH NO. 173
Tape punch (uncoded)



TAPE-ARD DUPLICATOR NO. 174
(shown below punch)
For automatically duplicating punched tapes use Duplicator No. 174, Tape Reader No. 171, and Tape-ard Punch No. 173.



TAPE-ARD HANDLING UNIT NO. 194
Handles 200 feet of one inch tape, no rewinding necessary.

Write for full information

CTI
CALIFORNIA TECHNICAL INDUSTRIES
DIVISION OF TEXTRON INC.
BELMONT 7, CALIFORNIA

Circle 717 on Page 35

More cycles! No stretch! Less punch wear!

New "Peerless" Fibre control tape wears 30 times longer than paper; costs 1/6th that of polyester film!

Need a tough tape that will take machine shop handling? A durable tape for repeat operations? Check the savings in new "Peerless" control tape. It's made of National Vulcanized Fibre, a cellulose plastic—the only tape of its kind!

Compare "Peerless" tape's long, cost-cutting cycle life:

Speed (CODES PER MINUTE)	Paper Tape (CYCLES)	"Peerless" (CYCLES)
1200	100 to 115	3,000 & over
620	1200 to 1900	30,000 & over

And check "Peerless" tape's amazing properties! It's extra tough, flexible, with high tensile and bending strength. It has high opacity, excellent abrasion resistance and is easily punched. Thicknesses: .0043" and .005"—heavier thicknesses available.

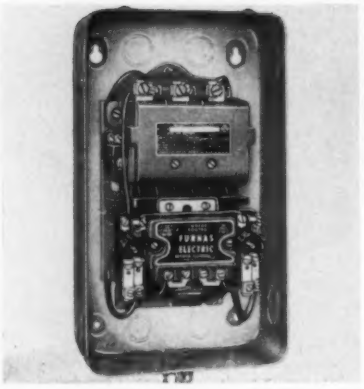
"Peerless" does not stretch in use. Precision-punched holes remain true. In addition, "Peerless" is *plastic-smooth* and impurity-free; friction and wear on punching and feeding equipment are cut to the minimum.

"Peerless" tape is available in any width. It is already proving its superior economies in tape life and cost on major automatic programming equipment in industry, government and business. Colors: Red, Gray, Blue, Black. Investigate now. Write for Free test sample and complete information. Dept. UU-3.

NATIONAL
VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE

In Canada:
NATIONAL FIBRE COMPANY OF CANADA, LTD., Toronto 3, Ontario

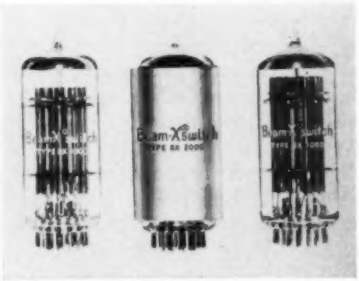
Circle 718 on Page 35



Motor Starters

Magnetic motor starters, Sizes 2 and 2½, incorporate trip free melting alloy type of thermal relays, simplified electromagnet design, greater flexibility for the field addition of pushbuttons, selector switches, or third overload modification kits. Model B three pole open and Type 1 General Purpose starters are interchangeable in mounting with superseded Model A. Magnet coils are molded type dual voltage (110-220 or 220/440) dual cycle (50-60). Coil has molded terminal board eliminating leads. Up to 3 auxiliary interlocks for pilot duty may be added. Other features include low wattage magnet, silver-cadmium oxide contacts, pressure terminals, fungus resistant coil, and identical mounting area for both sizes. **Furnas Electric Co.**, 1128 McKee St., Batavia, Ill.

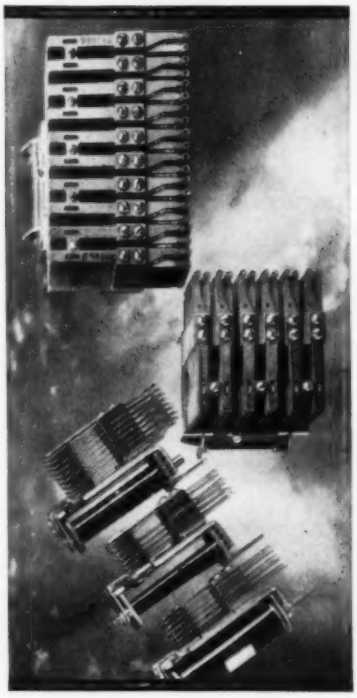
Circle 476 on Page 35



Tube Switches

Tube switches are insensitive to temperature, are automatically assembled to insure rugged construction, and have a 50,000 hour life potential. They have the ability to replace as many as 90 transistors, re-

Relays by Stromberg-Carlson



Telephone-type quality • reliability durability

TYPE A: general-purpose. Up to 20 Form "A" spring combinations.

TYPE B: gang-type. Up to 60 Form "A" spring combinations.

TYPE BB: up to 100 Form "A" springs.

TYPE C: two on one frame. Ideal where space is tight.

TYPE E: characteristics of Type A, plus universal mounting. Interchangeable with other makes.

Types A, B, and E are available in high-voltage models. Our assembly know-how is available to guide you in your specific application. If you desire, we can also provide wired mounting assemblies.

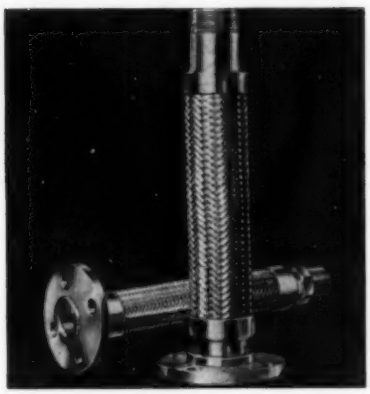
Details on request from these Stromberg-Carlson offices: Atlanta—750 Ponce de Leon Place N.E.; Chicago—564 W. Adams Street; Kansas City (Mo.)—2017 Grand Avenue; Rochester—1040 University Avenue; San Francisco—1805 Rollins Road.

STROMBERG-CARLSON
A DIVISION OF
GENERAL DYNAMICS

Circle 719 on Page 35

sistors, and diodes, in typical counting and distributing circuits. High current BX-3000 is designed to perform the functions of the standard beam switching tube Type 6700. Its 5.5 ma constant current output makes it capable of lighting multiple Nixie indicator tubes, both local and remote, operating relays, and performing other circuit functions which require its increased output power. The shielded general purpose BX-2000 is designed to allow the placing of tubes in direct contact with each other. It provides 3 ma of constant current output, sufficient to operate a Nixie tube, printers, and other associated circuitry. **Electronic Tube Div., Burroughs Corp.**, Box 1226, Plainfield, N. J.

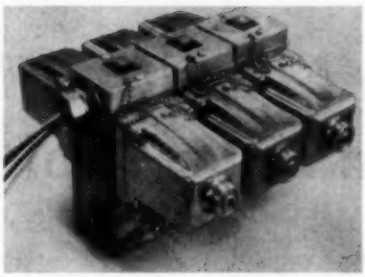
Circle 477 on Page 35



Pump Connectors

Recommended for the suction and discharge lines of all pumps, flexible pump connectors handle pressures to 1500 psig, depending on alloy, braid construction, and size. They are capable of handling temperatures to 1200F in stainless steel, to 800F in Monel and hot-dip galvanized steel, and to 450F in bronze. Furnished with threaded or flanged end connections to fit all standard piping sizes, Allflex pump connectors are available from ¼ to 16 in. in stainless steel, ¼ to 8 in. in bronze and hot-dip galvanized steel, and ¼ to 4 in. in Monel. Material, lengths, and construction are varied to suit conveyed fluid, pressures, temperatures, and movements encountered. **Allied Metal Hose Co.**, 8-14 38th Ave., Long Island City 1, N. Y.

Circle 478 on Page 35



Hydraulic and Air Valves

Line of ⅜-inch, high performance Hi-Cyclic direct acting solenoid valves is designed specifically for manifold mounting. The valves mount on 2⅝-inch centers, and up to five valves can be mounted on a manifold. They are available as double solenoid, or single solenoid, spring return types; 2, 3, or 4-way; 2 or 3 position, for air, vacuum, and all conventional hydraulic fluids. Seven spool types are available. These valves are equipped with built-in electrical junction boxes and are available furnished either with standard equipment, or to JIC standards. **Beckett-Harcum Co.**, Wilmington, Ohio.

Circle 479 on Page 35

If your product is . . .

TOO BIG
for use by a salesman or in a trade show.

TOO HEAVY
for a salesman to carry.

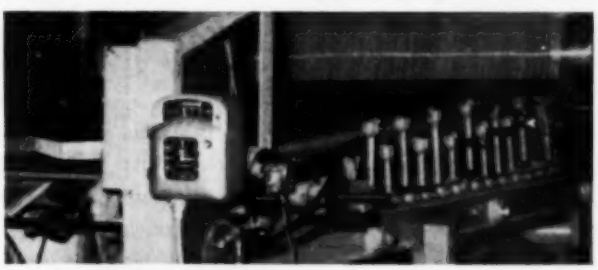
TOO EXPENSIVE
to give to your salesman and representatives.

TOO SMALL
to be able to demonstrate its features to the customer.

Used as a selling tool, a scale model will solve all these problems • A model can be constructed to show the features of your product where very often the actual article is not suitable • A picture is worth a thousand words • A model is worth a thousand pictures • Write for brochure describing how scale models can open doors and sell your product.

"VISUAL" Plant Layouts, Inc.
99 Pennsylvania Ave.,
Oakmont, Allegheny County, Penna.

Circle 720 on Page 35



At Burlington Mills . . .

A WAGNER® INDUSTRIAL RECORDING SYSTEM
records slasher production

Burlington Mills uses an Industrial Tachograph to measure the production efficiency of this slasher. The Tachograph is a precision recording device that lets you measure output versus time. It can be used wherever the control of speed, time and measurement is essential to the quality of your products.

Tachographs graphically record operation of one machine or an entire line...aid in quality control and time study programs ...help you determine production peaks and valleys, and nonproductive time. Chances are, Tachographs can help increase your mill's efficiency. Mail coupon below for full information.

Wagner Electric Corporation
6430 PLYMOUTH AVE., ST. LOUIS 33, MO., U. S. A.

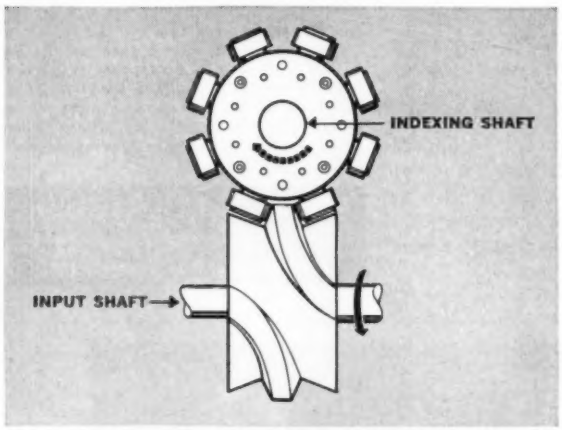
Please send a copy of Bulletin SU-144.

Name_____
Company_____
Address_____
City & State_____
Proposed Application_____
WI61-1

Circle 721 on Page 35

How Ferguson *ELIMINATES BACKLASH* in Index Tables

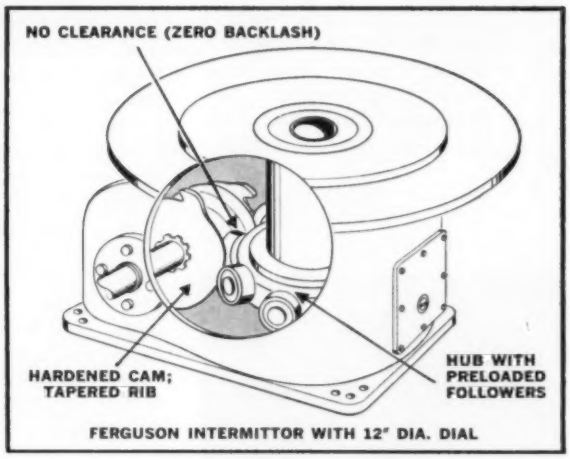
Backlash in indexing results in shock loads that affect the efficiency of a machine and the quality of its product. Most indexing mechanisms have inherent characteristics that cause backlash and poor dynamic conditions and prevent the designer from taking full advantage of modern feeds, tooling and methods that contribute to production economy.



Ferguson Intermittor Index Tables have inherent zero backlash and extreme precision which results in a rotary transfer machine base capable of operating speeds up to 500 indexes a minute. *A Ferguson index table never proves to be a limiting factor in the speed or performance of an automatic assembly machine.*

HERE'S WHY: The continuously rotating cam of a Ferguson indexing mechanism features a *tapered rib* along which two preloaded bearing followers roll, maintaining constant contact with no clearance between them and the rib. When the mechanism is in the rest, or dwell, position, a straight portion of the rib locks the followers with zero backlash and an indexing accuracy of .001". Wear on the hardened tool steel cam is infinitesimal (many have been in use for more than 25 years). Followers are rated for a minimum of 8,000 hours operation. If backlash occurs after this period the life of the drive may be renewed merely by replacing the standard followers.

NOTE HOW PRELOADED FOLLOWERS ENGAGE RIB



FERGUSON INTERMITTOR WITH 12" DIA. DIAL

Compare this with other types of indexing devices. A geneva drive, with its slotted wheel and driver, and a barrel cam with a grooved track which engages one follower at a time, must have clearance in the slot or groove to allow passage of the follower. The slightest amount of clearance causes backlash. As the slot or groove wears, the clearance becomes greater and the backlash condition worsens. At the higher, more profitable operating speeds poor dynamics cause wear on other parts of the machine. The user must choose between frequent downtime for repairs or slower speeds . . . He is the loser in either case.

FREE DESIGN DATA — Load ratings, dimensions and application and installation information about standard and stock Intermittors, Ferguson Drives and in-line machines are contained in a single 36 page catalog. Every designer should have one in his library . . . Write Ferguson—Ask for Catalog No. 160.

FERGUSON
MACHINE COMPANY
A Division of Universal Match Corporation
7818 Maplewood Court • St. Louis 17, Missouri

Circle 722 on Page 35

AUTOMATION

catalogs and literature

Latest automation information. For copies use card on page 35.

Motor Controller

Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.—8 page bulletin—Data are contained in Bulletin 14B9739 on a high voltage motor controller, designated Space-Maker. This controller, in the 2000-5000 volt range, employs a two-high unit design. Available for squirrel-cage, wound-rotor, and synchronous motors up to 2500 hp at 4 to 5 kv and 1500 hp at 2.3 kv, reversing or nonreversing, full-voltage or reduced-voltage starting, controller carries a 60 kv impluse rating and tests at 15 kv dielectric for 1 minute.

Circle 480 on Page 35

Automatic Bar Machines

American Bechler Corp., 28 Harbor St., Stamford, Conn.—4 page pamphlet—Bulletin AR-60 contains information regarding a line of Model AR Swiss automatic bar machines. Operational principles of this high precision equipment are explained with parts described in detail as to function and features. Also covered are a three spindle Universal Attachment and a 6 spindle hydraulic drum turret for performing end operations such as, centering, drilling, reaming, threading, and tapping.

Circle 481 on Page 35

Photoelectric Controls

Autotron Inc., 3629 N. Vermilion, Danville, Ill.—24 page catalog—Catalog 60 provides data on a line of photoelectric and other electronic controls. The following list includes a few of the types of controls covered: Moderately sensitive photoelectric controls, fast operating-very sensitive models, fail safe controls, photoelectric controls with adjustable time delay, electronic timing controls, and bin level controls. Various applications are both illustrated and explained.

Circle 482 on Page 35

Cooling Tower Design

Bell & Gossett Co., Morton Grove, Ill. —8 page bulletin—Bulletin CT-360 entitled "Six Step Manual for Sizing Cooling Tower Pumps and Piping" is offered as a guide to help designers of cooling tower installations plan their pump and piping requirements. Charts illustrate the capacities in gallons per minute of Series 1522 and 1531 pumps. Two tables are included, one showing total equivalent pipe footage for different pump pressure heads, and the other showing carrying capacities of various pipe sizes in gallons per minute.

Circle 483 on Page 35

Flexible Shafts

S. S. White Industrial Div., Dept. P., 10 E. 40th St., New York 16, N. Y.—89 page handbook—A simplified approach to the selection of flexible shafting is described in this manual. General flexible shaft information is given, followed by data on standard, pre-engineered, and custom designed flexible shafts. Information on a new, simplified engaging system based on integral-formed drive squares is included as well as data on improved Series 7 (remote control) and Series 9 (power drive) flexible shafts.

Circle 484 on Page 35

Stacker Cranes

American MonoRail Co., 1111 E. 200th St., Cleveland 17, Ohio—12 page bulletin —Bulletin SB-1 illustrates and describes various applications of a line of stacker cranes in the warehousing of steel bar stock, dies, rolls of cellophane and aluminimum foil, drums and pallets. Details are given on a newly designed stacker with telescoping mast. Stacker cranes are designed to permit narrow aisles, high stacking, and maximum use of cubic space plus complete accessibility of every load stored.

Circle 485 on Page 35

Proximity Switches

Electro Products Laboratories Inc., 4501 Ravenswood Ave., Chicago 40, Ill.—8 page bulletin—Catalog EDPS-80 provides data on a line of proximity switches used for such industrial applications as limit switches, positioning controls, detection devices, and sensing elements for counters. A complete proximity switch consists of a sensing head, a connecting cable, and a control amplifier. Sensing heads are actuated by both magnetic and non-magnetic metals without physical contact. Also covered in booklet are time delay proximity switches featuring optional plug-in time delay modules to suit specific control requirements.

Circle 486 on Page 35

Gas Survey Recorder

Fischer & Porter Co., 713 Jacksonville Rd., Warminster, Pa.—4 page pamphlet— Catalog 35-1543 provides data on a gas survey recorder that can be coupled to consumer or industrial type meters. Catalog reviews the basis for scientific gas demand studies and describes how survey costs can be minimized. The installation and mechanical operation of a gas recorder, and the direct transfer of its punched tape data to a computer for study, is described and illustrated.

Circle 487 on Page 35

Water Detector

Ipsen Industries Inc., Dept. 21, P. O. Box 500, Rockford, Ill.—2 page pamphlet —Bulletin WS-60 describes the installation and operation of a safety device that detects the presence of water in enclosed type oil quench tanks. This device can be used with any sealed quench tank that has good circulation or agitation. Information includes several illustrations that show the components of the device. A graph shows response times for different water contamination levels of quenching oil at various working temperatures.

Circle 488 on Page 35

Wood Wear Strips

Paramount Oilless Bearing Co., Inc., Dept. A, 99 Hope Ave., Worcester, Mass. —6 page pamphlet—Bulletin describes a line of self-lubricating wood wear strips used for trouble-free operation of existing or new conveying machinery. This hardwood wear strip is machined in all practical widths, lengths, and thicknesses. It may be bored, counterbored, slotted, grooved, tapped, or rabbeted to conform to any particular mounting specifications. Typical applications and adaptations are illustrated.

Circle 489 on Page 35

Control Media Preparation

Wichita Div., Boeing Airplane Co., 3801 S. Oliver, Wichita 1, Kans.—50 page handbook—Data are provided in Booklet D3-2924 about available control media preparation facilities. Complete tapes for numerically controlled machines, including drawing data conversion, parts programming, computer usage, tape verification, tool and cutter design, or part fabri-

cation are available. Computer programs, designated Waldo, are capable of providing complete control media for mass production. These three-dimensional programs can be processed completely through high-speed computers. Training programs are offered covering all phases and aspects of numerical control and computer usage.

Circle 490 on Page 35

Magnetic Tapes

Reeves Soundcraft Corp., Advertising Dept., Great Pasture Rd., Danbury, Conn.—4 pamphlets—Literature file features detailed information on a line of instrumentation tapes. This line includes computer tape, telemetry tape, numerical control tape, and general purpose tape. The catalog sheets are illustrated and contain information on the physical and magnetic properties of each product. Tape manufacturing processes such as uni-level coating, double coating, and micropolishing are discussed.

Circle 491 on Page 35

Pin and Socket Connectors

AMP Inc., Harrisburg, Pa.—6 page pamphlet—Subject of this brochure is a line of pin and socket type multiple connectors. AMPin-cert connectors are available in a variety of sizes and configurations. They feature snap-in contacts and solderless termination of contact to wire through a compression-crimp technique. Diagrams illustrate five available contact types. Contact current rating for the connectors is 5 amperes, and temperature range is up to 400 F.

Circle 492 on Page 35

Roller Chain Products

Diamond Chain Co. Inc., 402 Kentucky Ave., Indianapolis 7, Ind.—120 page catalog—Stock roller chain, sprocket, and coupling Catalog 760 carries new ARSCM horsepower ratings. In addition to engineering data on stock roller chain and sprockets, information is given on a line of products in the power transmission and conveying field. These are the Dura-Weld top plate conveyor chain, the Tuf-Flex heavy duty roller chain, the Micropitch miniature roller chain, and Hi-Cap flexible couplings.

Circle 493 on Page 35

Die Casting Machines

Cleveland Automatic Machine Co., 4932 Beech St., Cincinnati 12, Ohio—12 page booklet—Line of high pressure hydraulic casting machines for both hot and cold chamber casting is covered in this brochure. Machines available range from 100 to 2000-ton models. Included in the brochure are details on optional features such as die strippers, automatic lubrication, and vacuum die casting. Photographs illustrate construction features of the various models.

Circle 494 on Page 35

Low-Pressure Regulators

American Meter Co., Advertising Dept., 920 Payne Ave., Erie, Pa.—4 page pamphlet—Bulletin 131 contains data on Type CBV Series 300 low-pressure regulators developed for reducing, relief, and back pressure applications. Maximum inlet pressure is 400 psi and maximum outlet pressure 14 inches w.c. These regulators feature a high degree of interchangeability which permits quick conversions for a variety of services. Inside and outside weight loaded and pilot loaded models with parabolic or quick opening valves are available.

Circle 495 on Page 35

Automatic Weighing Systems

Dynametrics Corp., Sales Dept., Northwest Industrial Park, Burlington, Mass.—16 page booklet—Catalog 200 contains data on a line of automatic weighing systems and components designed for industrial use. Featured in this booklet is a Dynabatch control system which uses a binary method for simplicity in remote weight setting. Schematic diagrams illustrate construction details as well as operating characteristics of various systems.

Circle 496 on Page 35

Table Feeder

B-I-F Industries, P. O. Box 1342, Providence 1, R. I.—4 page pamphlet—Data are contained in Bulletin 50.20-2 on table feeder developed for feeding dry chemical compounds accurately at low rates. This feeder is accurate within ±5 per cent by weight, depending upon physical characteristics of material fed. It has a hopper capacity of 5 cu ft and a feeding of range of 100 to 1—the minimum rate being 1 per cent of the maximum. Principal dimensions of the unit are indicated by schematic drawings.

Circle 497 on Page 35

"On the Button"...

DIAMETERS
18"
24"
30"
36"
42"
48"
54"
60"

Number of stations to suit your requirements

PDC-JIC SERIES
"AUTOMATIC"
Geneva Motion Index Table

YOUR CHOICE
- Electric Motor Drive
- Fluid Motor Drive
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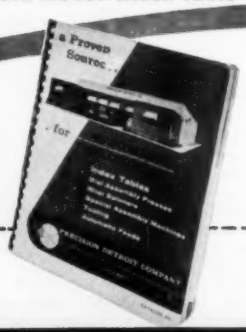

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Circle 723 on Page 35

Paint Finishing Systems

J. O. Ross Engineering, Div., Midland-Ross Corp., 730 3rd Ave., New York 17, N. Y.—12 page booklet—Bulletin PF-400 describes a line of paint finishing systems and component units. A pictorial story of a typical finishing line installation is presented. A diagram indicates the arrangement of system units. Metal preparation units, spray booths, flow-coat units, ovens, air heaters, and paint finishing conveyors are both explained and illustrated.

Circle 498 on Page 35

Digital Modules

Computer Control Co. Inc., 983 Concord St., Framingham, Mass.—12 page booklet—Catalog S describes 30-PAC type plug-in digital modules designed to operate from dc to 1 megacycle within a temperature range of −20 to +55C. High component densities, easy-to-follow circuit configurations, and use of a minimum number of component types are discussed. Also explained is the compatibility between modules as well as their ability to drive T-PAC units.

Circle 499 on Page 35

Lubrication Systems

Bijur Lubricating Corp., 151 W. Passaic St, Rochelle Park, N. J.—4 page pamphlet—Bulletin describes and illustrates three basic elements of automatic machine lubrication—lubricators, distribution systems, and metering units for regulating the amount of oil flow at each bearing. Eight types of lubricators are shown. Distribution system details include information

on a variety of tubing, junctions, and flexible hoses. Cutaway view shows internal construction of the metering unit.

Circle 500 on Page 35

Strapping Methods and Tools

Signode Steel Strapping Co., 2600 N. Western Ave., Chicago 47, Ill.—40 page handbook—Booklet entitled "Better Ways to Package, Unitize, and Ship" serves as a basic reference guide to this company's line of strapping methods and tools. Included in the booklet are descriptions of compression strapping and jib crane systems. Details are provided on a heavy duty model TH feed wheel tensioner, an air-powered RCNS sealer, dispensers, and strap cutters. A list of twelve strapping pointers is included. Charts of available materials and equipment are provided.

Circle 501 on Page 35

Electronic Computer

Data Processing Div., Royal McBee Corp., Port Chester, N. Y.—6 page pamphlet—Report S-480 explains in detail how an electronic computer, LGP-30, calculates incentive payroll, sales analysis, and finished goods inventory. It contains sample output forms and promotional flow charts relative to each of the programs. Future areas of use are in rental rate accounting, shipment programming, and production control.

Circle 502 on Page 35

Industrial Belting

Boston Woven Hose & Rubber Div., American Biltrite Rubber Co., P. O. Box 1071, Boston 3, Mass.—36 page catalog—Line of conveyor, elevator, and transmission belting is covered in Catalog 1003-E250. Cross section illustrations show construction of each belt. Tables indicate belt weights, gages, fabrics, and recommendations. Details are provided on features such as balanced belt construction, Dulon covers, and hazard-proof carcasses.

Circle 503 on Page 35

Air Transmitter

B-I-F Industries, 345 Harris Ave., Providence, R. I.—2 page pamphlet—Data on an air transmitter, designated Omega Model 86-10, are contained in Bulletin 86.20-1. This transmitter produces pneumatic pressures proportional to the speed of rotation of a primary unit and can be used with recording instruments or in control or pacing feeders. A low-speed input of 20 rpm produces an air output of 15 psi. Only power required is that necessary to rotate a flexible cable.

Circle 504 on Page 35

Packaging Adhesives

Industrial Adhesives Div., Armour Alliance Industries, 16123 Armour St. N. E., Alliance, Ohio—16 page booklet—Catalog A100 contains data on a line of packaging and paper converting adhesives. It provides details on adhesives used for applications such as carton sealing, case sealing, window boxes, tube winding, labeling, etc. Features as well as chemical and physical properties of the various adhesives are provided. Photographs illustrate typical applications.

Circle 505 on Page 35

Liquid-Level Switch

Acoustica Associates Inc., Gauge and Control Marketing Dept., 10400 Aviation Blvd, Los Angeles 45, Calif.—4 page pamphlet—Subject of Bulletin C-152-1 is a unitized liquid-level switch which combines an ultrasonic probe and a transistorized control. In addition to specifications, this folder also relates how the liquid-level sensor, either as an integral or separate unit, is capable of monitoring a large number of liquids, including cryogenic liquids, chemicals, and petroleum products. Level sensing is unaffected by droplets, foam, or vapors in a vessel.

Circle 506 on Page 35

Resilient Couplings

Falk Corp., Box 492, Milwaukee 1, Wis.—24 page catalog—Bulletin 4100 describes a line of torsionally resilient Steelflex couplings. Coupling types, dimensions, and methods of selection are included. Grid-groove coupling design protects connected machines against shock, vibration, and misalignment. Charts and tables contain up-to-date engineering data.

Circle 507 on Page 35

Indicating Rotameter

Brooks Instrument Co. Inc., Hatfield, Pa.—4 page pamphlet—Bulletin 131 provides data on Model Series 1400 high pressure indicating rotameter. This instrument is designed for pressures up to 5000 psig at 200 F, and flow rates up to 4.60 gpm of water and 19.10 scfm of air. It is available with 150 mm or 250 mm scale lengths. Tables indicate various unit capacities.

Circle 508 on Page 35

Filling Machines

Arthur Colton Co., 3400 E. Lafayette, Detroit 7, Mich.—8 page bulletin—Brochure AC-60 revised describes a line of Colton and Colton-Hope filling machines for liquids, creams, pastes, paints, chemicals, and food products. Colton products include single-purpose tube fillers, closers, and crimpers; combination liquid and paste fillers; volumetric liquid fillers; and floor-type multiple liquid fillers in 4, 6, 8, and 12-nozzle designs. Colton-Hope filling machines covered include several models of automatic straight-line volumetric filling machines and a 16-station rotary filler. A data table aids in the selection of the proper machine for specific materials and rates.

Circle 509 on Page 35

Inventory Cost Report

Dasol Corp., 205 E. 42nd St., New York 17, N. Y.—4 page pamphlet—Booklet is an audit summary of inventory carrying charges prepared to help managements pinpoint their own costs. Reducing physical distribution costs is seen as a method of effecting cost reduction and improving operations. Typical case histories are cited.

Circle 510 on Page 35

Fluid Power Equipment

Alkon Products Corp., 200 Central Ave., Hawthorne, N. J.—24 page catalog—Details are provided in this catalog on a

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Circle 724 on Page 35

line of pneumatic and hydraulic components such as cylinders, valves and a drill unit. Included in the material are product data and specifications, schematics, price lists, and discount schedules. Feature of the catalog is a new Series B interchangeable cylinder for air and oil service.

Circle 511 on Page 35

Miniature Relays

Automatic Electric Sales Corp., Subsidiary, General Telephone & Electronics, Northlake, Ill.—4 page pamphlet—Bulletin 1942-A covers a line of Class E relays featuring miniaturized design. These relays are suited for many small-size computer applications or wherever weight reduction or size are important. Available models include quick acting; slow operate; slow release; slow acting (slow operate and slow release); alternating current; and snap action contacts. Relay operating voltage is up to 220 v dc or ac. Contacts are twin palladium-silver make-or-break, rated 135 watts (maximum 3 amp noninductive load). Large, single contacts are available for heavy duty. Bulletin includes mounting data for the line.

Circle 512 on Page 35

Honing Equipment

Barnes Drill Co., 836 Chestnut St., Rockford, Ill.—16 page booklet—Catalog 200 describes internal, external, and straight line honing processes. The development of honing and the honing process are explained, and typical honed parts are illustrated. Charts list spindle speeds and coolants for typical honing operations. Various machines, tools, and abrasives included in the line are illustrated.

Circle 513 on Page 35

Weight Calculator

Scale Specialties, Box 574, Denville, N. J. —4 page pamphlet—Subject of this brochure is a weight calculator used alongside filler lines to weigh and record weights of items on production lines. Datamatic strip charts record and average weights. Counters total the number of units tested and overweights and underweights. An attachment indicates the number of packages that fall within any of 15 weight cells to show a condensed analysis of weight distribution.

Circle 514 on Page 35

Numerically Controlled Lathe

Cincinnati Lathe and Tool Co., 3207 Disney St., Cincinnati 9, Ohio—8 page bulletin—Numerically controlled lathe is subject of Catalog N-250. Taped commands, read through an Acramatic control console, provide automatic control of all machining and operating functions—tool position and feed, tool selection, spindle speed selection, and coolant flow. Lathe features reduced setup time. Method of programming is discussed, and general specifications are provided. Standard and optional equipment is covered.

Circle 515 on Page 35

Abrasive Belt Machines

Carborundum Co., P. O. Box 337, Niagara Falls, N. Y.—4 page pamphlet—Brochure CUB 217 sets forth specifications and advantages of Series 150 abrasive belt machines for use in the woodworking and metalworking industries. These machines are capable of handling paneling from 1/20 to 3 inches thick and 49 inches wide. Metals may be finished and deburred. Features include automatic belt tensioning and tracking, and constant through feed.

Circle 516 on Page 35

Photoelectric Delay Relay

Farmer Electric Products Co. Inc., 2300 Washington St., Newton Lower Falls, Mass.—2 page pamphlet—Bulletin PE-5 provides details on a photoelectric scanner relay that provides an adjustable time delay between the changing of light intensity and operation of a load relay. Typical applications include monitoring the movement of parts through a machine or along a conveyor; detecting small parts or parts too light to actuate a limit switch; providing a signal when jamups occur on moving parts; and providing a signal when parts fail to feed on a moving conveyor.

Circle 517 on Page 35

Industrial Valves

General Kinetics Corp., 197 S. Van Brunt St., Englewood, N. J.—15 page booklet—Covered in Bulletin GV 101 is a line of industrial valves. P-K Paul control valves are available in sizes ranging from 1/4 to 14 inches and are capable

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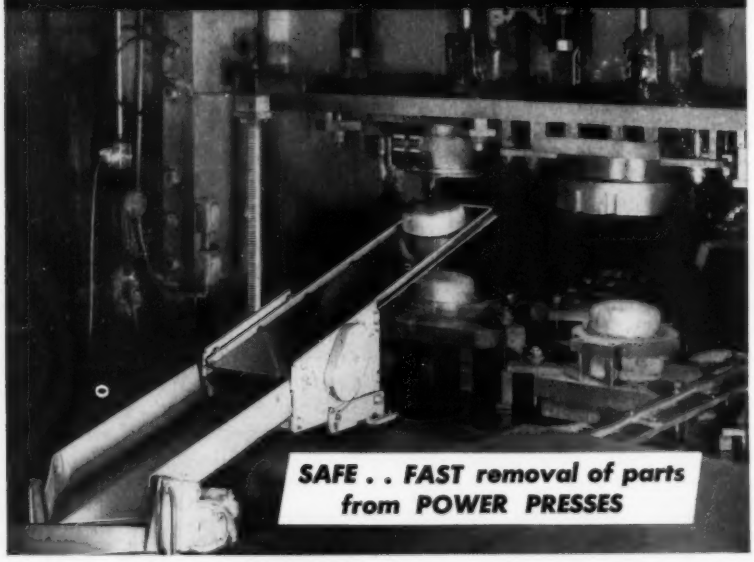

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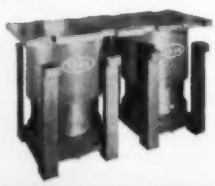

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Circle 725 on Page 35

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Circle 726 on Page 35

of handling pressures from high vacuum through 50,000 psi, and temperatures from −425 through +1800 F. They are suitable for the control of virtually all types of liquids, gases, vapors, and slurries. Spherical plug type valves and Ludeman hose valves are also covered.

Circle 518 on Page 35

Capacitance Level Controls

Weighing & Controls Inc., Advertising Dept., Industrial Park, Hatboro, Pa.—6 page pamphlet—Bulletin JH2674-60-10 describes a line of Prob-A-Larm capacitance level controls. These controls are designed for detecting and controlling quantities and levels of liquids, powders, and grains in vessels. Model 000 is a standard chassis unit for mounting on a vessel. Model 001 consists of two units—a probe unit and a remote master unit. Diagrams illustrate typical applications.

Circle 519 on Page 35

Wire Cloth and Belting

Cambridge Wire Cloth Co., Cambridge, Md.—two 6 page pamphlets—Bulletin 115 describes and illustrates various types and grades of industrial wire cloth that are available in bulk and fabricated parts. It contains a listing of trade definitions of terms most frequently used in the specification of wire cloth. Bulletin 116 describes and illustrates typical specifications of metal-mesh conveyor belts and shows a number of operating installations.

Circle 520 on Page 35

Way Type Feed Units

Buhr Machine Tool Co., Ann Arbor, Mich.—4 page pamphlet—Brochure provides details on hydraulic way type feed units. The units are available in four sizes (602, 603, 604, and 605) to meet various job requirements. They can be equipped with an integral motor bracket type platen or standard flat platen. Hydraulic valve and manifold components and plug-in limit switches are common and interchangeable among all four size units.

Circle 521 on Page 35

Computing Resolvers

Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J.—16 page booklet—Manual describes the characteristics of computing resolvers. Definitive properties such as function error are explained, and techniques of measurement are set forth. Functions and features of a computing resolver test set, Model MST-8QSA-1, are listed.

Circle 522 on Page 35

Portable Belt Conveyors

Rapids-Standard Co. Inc., 342 Rapistan Bldg., Grand Rapids, Mich.—6 page pamphlet—Subject of Bulletin 300 is a line of portable belt conveyors. Principal applications include loading and unloading trucks, moving materials in and out of elevated storage areas, and stacking and unstacking goods. Three types of conveyors illustrated and described are: A light weight aluminum unit, a general duty unit, and a heavy duty unit.

Circle 523 on Page 35

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Circle 727 on Page 35

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Circle 728 on Page 35

AUTOMATION abstracts

COMPUTER CONTROL OF BOILERS

By G. W. KESSLER
Chief Engineer, Boiler Div.
Babcock & Wilcox Co.
Barberton, Ohio

SINCE the application of computer monitoring and computer control of boilers is in its infancy, we believe that for the initial applications we should adopt the concept that the computer merely substitutes a properly sequenced program for the functions previously performed by human operators. These functions include the monitoring of a multitude of conditions—such as temperatures, pressures, flows, fluid levels, the combustion process, damper and valve positions, and the operation of auxiliaries—and correlating them to determine the action necessary, through the medium of conventional automatic controls, to obtain the conditions desired.

Simply stated, the limits of computer participation in plant operation are just those given to it by the individuals who have programmed its actions. Herein lies the potential which, if attained, will provide the major benefits of automation. If—excluding mechanical failures—the computer is provided with the correct monitoring and sensing devices and if it is programmed to take into account every conceivable eventuality that can occur during boiler operation, it can prevent furnace explosions or other casualties by either correcting the conditions or by tripping out pieces of equipment or the entire unit, before damage can occur. Other benefits include the following:

1. A reduction in the number of outages. By taking prompt and corrective actions during emergency conditions, the chain reactions, so often encountered, can be stopped.

2. Less maintenance. A better control of the temperatures and the pressures throughout the boiler and to the turbine, and of the rates of temperature change, will minimize overstressing and overheating, and reduce the possibility of pressure part failures.

3. Increased average unit efficiency. Improved efficiency, and consequently, fuel savings can be obtained by more precise monitoring of the actual boiler operation conditions and the heat rate data on which to base unit loading.

4. Fewer operating personnel. This is primarily a future consideration, since the initial efforts may require more and higher caliber manpower.

However, against these benefits must be weighed these disadvantages:

1. Complexity. The computer and its tie-in to the controls adds a most intricate assemblage of equipment and electrical circuits to the power plant.

2. Computer maintenance. This is imperative and must be conducted on a regularly prescribed schedule if high availability is to be attained.

3. Unknown reliability. Since the computer is an integral part of the control and operating system, it must have high reliability. This has not, as yet, been proved and any outage of the computer will shut down the boiler unless prearrangements provide for operation by station personnel during computer outages.

4. Increased costs. The computer is an expensive item, and the costs of engineering the system are appreciable.

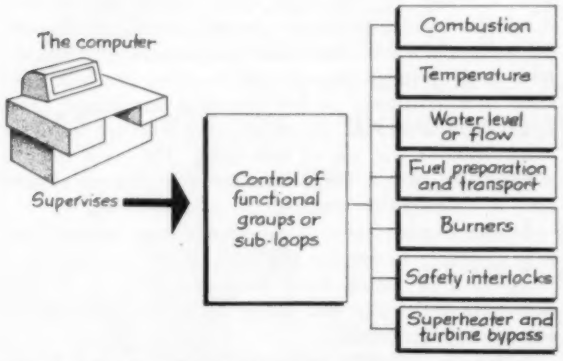

Fig. 1—Elements of automatic boiler can be divided into functional groups for which techniques exist that permit automatic operation. Considering the unknown factors in computer control technology, a suggested approach is that the computer initially be applied to supervise the functional sub-loops similar to manner of human operator.

There are several approaches by which computers may be applied to power-plant operation. One approach is that taken by the Southern California Edison Co. for units 3 and 4 at Huntington Beach. In this arrangement, the computer supervises the control of functional groups, or sub-loops. These sub-loops can include: 1. The combustion control system, which should, perhaps, more correctly be called the Boiler-Turbine-Generator control system, particularly when applied to Universal Pressure Boilers. 2. The steam and reheated steam temperature control system. 3. The water level or water flow control system. 4. The fuel preparation and transport system. 5. The burner control system. 6. The standard safety interlock system. 7. The superheater and turbine by-pass and flash tank system.

During startup and shutdown periods the computer controls operation through the sub-loops, following the step by step sequence programmed. At appropriate points in the sequence, the computer releases the sub-loops to their own automatic operation or takes over operation from the sub-loops. During normal opera-

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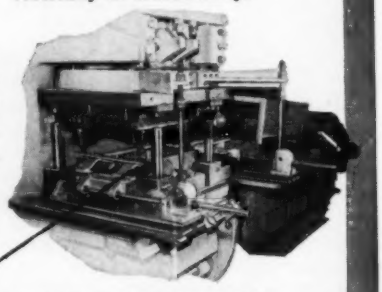

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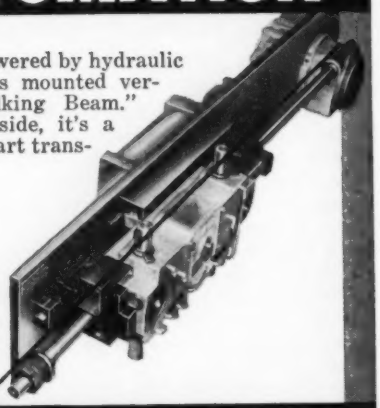

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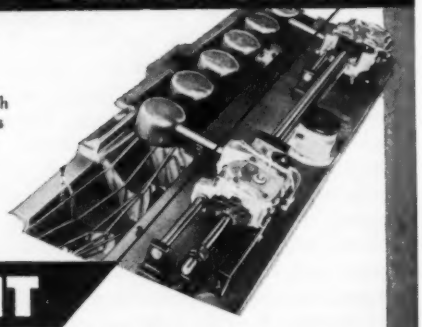

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tion, the computer scans and commands, and issues alarms when limits are exceeded or when abnormal conditions, which it has been programmed to recognize, develop. Through its many hundreds of scan points, it can diagnose upset conditions and take corrective action to restore the condition to normal. In addition, the computer prints out the operation data for record purposes and also calculates the heat rate based upon the actual data.

The application of computer monitoring and supervision to boiler operation has not created any insurmountable problems when conventional sub-loop controls are used. Engineering ingenuity and time are required to apply operating drives to the valves and systems which are normally manually operated, but such mechanisms are available. However, a tremendous amount of engineering time and know-how is required to establish the type and the location of all of the sensing devices required to provide the computer with the necessary information so that it can safely supervise and control the operation of the boiler through normal startups, normal operation (including load swings), normal shutdowns, emergency shutdowns, or tripouts, and hot restarts. Even more engineering talent is required to sequence the operations and to determine the safety interlocks and tripout information required for all of the foreseeable conditions which could possibly occur. All eventualities, however remote, must be programmed into the computer so that it will take the correct action; and failure to consider any possibility could result in a casualty to the unit.

Ultimately, the functions of the sub-loop controls probably will be taken over entirely by the computer; but to do this its memory and reference or address system capacity will have to be greatly increased since the number of computer programs required will be multiplied many times. An approach in this general direction is being engineered by one of the large utilities. They plan the use of sub-loops similar to those used at Huntington Beach. However, in this case, the computer will not only monitor the operations of the sub-loops during normal automatic operation, but will actually go into the three major sub-loops—the boiler-turbine-generator control system, the burner control system, and the steam temperature control system—and optimize the controls to effect the best possible unit efficiency under changing conditions. The application also will utilize direct operation in some areas without the use of sub-loops. This will require a computer with a large memory and address system and a considerable amount of programming.

In the present state of automation, we believe that it is desirable to employ the full use of sub-loop controls, most of which have been developed to a high degree of reliability and safety when properly maintained and supervised.

Although complete automatic burner control is the prime essential for boiler automation, equipment also is important and essential. Some of this equipment, even the best that is commercially available, may be weak links in the chain of automation. In particular, the equipment which must be made more accurate, sensitive, and reliable includes:

1. Pressure switches. These must have a wider range, repeatability, little or no hysteresis, and very accurate set points.

2. Electrical equipment requiring contactors or relays. This has not been satisfactory, with the result that transistorized circuits are being used in every possible circuit of the latest controls.

3. Solenoid valves. They are definitely weak points in the system and should be eliminated in every possible application. They limit the use of pneumatic controls in the sub-loops and, for this reason, sub-loops of future automated plants undoubtedly will be electrically controlled.

4. Gas analyzing equipment. Maintenance must be reduced and the time lag between sampling and the indicating of results must be decreased.

5. Flow measuring equipment. The measurements fall far short of those needed; perhaps, whole new techniques of flow measurements will have to be developed. The potential of truly accurate flow measurement is enormous. Input-output efficiencies could be determined; pressure-part failures could be detected and cross checks on fuel-air ratios and gas analyses would permit operation at the highest possible efficiencies.

6. Sampling equipment. Representative sampling is important in today's power-plant operation and will be even more important in computer automation. Present sampling devices permit automation, but the techniques must be improved or the potential economies they can provide will never be realized. There are instruments, undesigned as yet, which probably will become a part of future automation. Some of these may provide for automatic chemical analyses of feedwater, ultimate analyses of fuel, and calorific heat contents of coal and oil.

From a paper entitled "Automation—The Application of Computers to Automatic Boiler Operation," presented at ASME-AIEE Power Conference, Philadelphia, September, 1960.

ELEMENTS OF AUTOMATIC ASSEMBLY

By ROBERT L. ESKEN
Supervisor, Engineering & Sales Application
Autometrology Section
Sheffield Corp.
Dayton, Ohio

THE DEGREE to which automatic assembly can be used depends, in part, on the ability of the product designer to incorporate into the design of each component characteristics for mechanical conveying, feeding, positioning, and fitting.

In designing or redesigning a product for automatic assembly, the product designer must remember that the cost of adding part characteristics necessary for automatic assembly will be outweighed by the large-scale economies of automatic assembly, thereby resulting in a decrease in over-all manufacturing cost.

The efficiency of automatic assembly machines depends on the laws of probability to a large degree. Hoppers, vibratory feeders, gravity chutes, consistent fitting parts are but a few of the factors affected by probability. The product designer can, with some consideration to assembly methods, reduce the probability factor.

Before any attempt should be made to design products for automatic assembly, some of the factors encountered in automatic assembly must be understood. Two of these factors are part handling and product parameters. There are a number of subdivisions in these categories and each will be touched on briefly.

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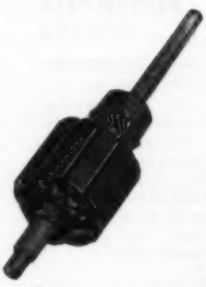

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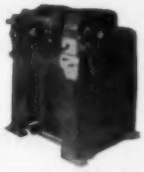
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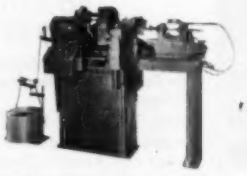
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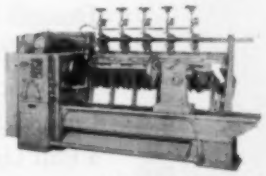
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machines. They are manual, magazine, and automatic feed. Which system is used must be determined by several factors, production rate, cost, and the inherent characteristics of each component part. Often it is necessary to combine two or more systems in one machine.

Manual feed is generally used with extremely large parts because large parts may be damaged if allowed to bump into one another in hoppers and feed chutes. Also, as magazines and automatic feeding systems should have at least a ½-hour supply, the space requirement to hold large-size parts would become excessive. Product design can help to improve manual feeding. Manual feeding is a monotonous job. If a worker has to think each time he places a part into a machine he soon becomes tired, his efficiency drops, and his weariness may result in damage to the machine or part.

In order to prevent this, part design for manual feed should feature some physical characteristic such as a protrusion, hole, or the like, to enable the operator to load and orient the part into the receiving station by relying solely on his subconscious and sense of touch. Parts should be free of sharp edges and burrs to permit the worker to wear thin gloves or use bare hands. Also, the shape of the part should be such that it does not become tangled with others when picked out of the bin or tote box.

Machines operating at high speeds require magazine feed. The use of magazines permits parts to be loaded at some point isolated from the machine. This is generally a manual operation performed at a rate to keep pace with production. As would be expected, the same problems and solutions as outlined for manual feed apply to magazine feeding. Magazines can also be loaded as part of the manufacturing process. For example, wire retaining rings are especially suitable for this method. The wire is wound in coil on a mandrel during manufacture after which the coils are sliced into individual rings. As a result, the mandrel is the magazine and it is loaded directly into the assembly machine.

Thin stampings such as leaf springs, contact arms, gaskets, shims, and so on, can be stamped in continuous strip without separation. The strip is wound in a coil and the coil placed in the assembly machine which incorporates the mechanism for separation of individual parts.

The optimum sought in all automatic assembly machines is fully automatic operation of all of the equipment involved, including part feeding. Product design can dictate to a great degree the accomplishment of this goal. There are two systems for automatic feeding. In many cases, both systems are used with one complementing the other. The two systems are part-feeding hoppers and conveying mechanisms.

The production rate required determines whether hopper feeding can be used. In some cases, multiple hoppers can be used; however, experience indicates the fewer there are the better the system. The feeding rate of a part-feeding hopper is not controlled entirely by its own capabilities but rather by the laws of

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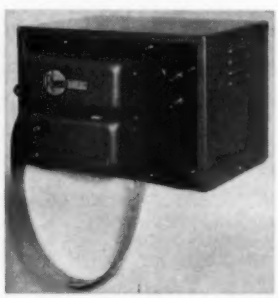

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probability.

Part-feeding hoppers motivate a flow of material properly oriented in a controlled direction and rate. The part-feeding hopper can be supplied automatically from a bulk-storage hopper or manually.

Devices used in part-feeding hoppers rely on the ability of a part to fall, position, or deposit itself in a given manner. The hopper engineer tries to determine for each part the position it is most likely to maintain. He then inserts devices into the system to eject all parts not maintaining this position. Thus, the law of probability determines the number of parts that will be fed properly oriented.

Product design can greatly improve hopper performance by providing inherent characteristics for part feeding. Devices such as off-center weight distribution, lugs, and slots can be used. Also, in the case of cylindrical parts if the length is 25 per cent or more longer or shorter than its diameter, feeding efficiency is better.

Conveying mechanisms frequently used in handling parts are gravity chutes, conveyor belts and chains, indexing chains and tables, transfer bars and fingers, and pallet index systems. All these systems require the parts to be placed in position by any of the methods already described, by integrated production lines, or directly from the manufacturing operation. If the product design follows the parameters outlined for feeding systems, little difficulty would be encountered in using any one of the conveying mechanisms.

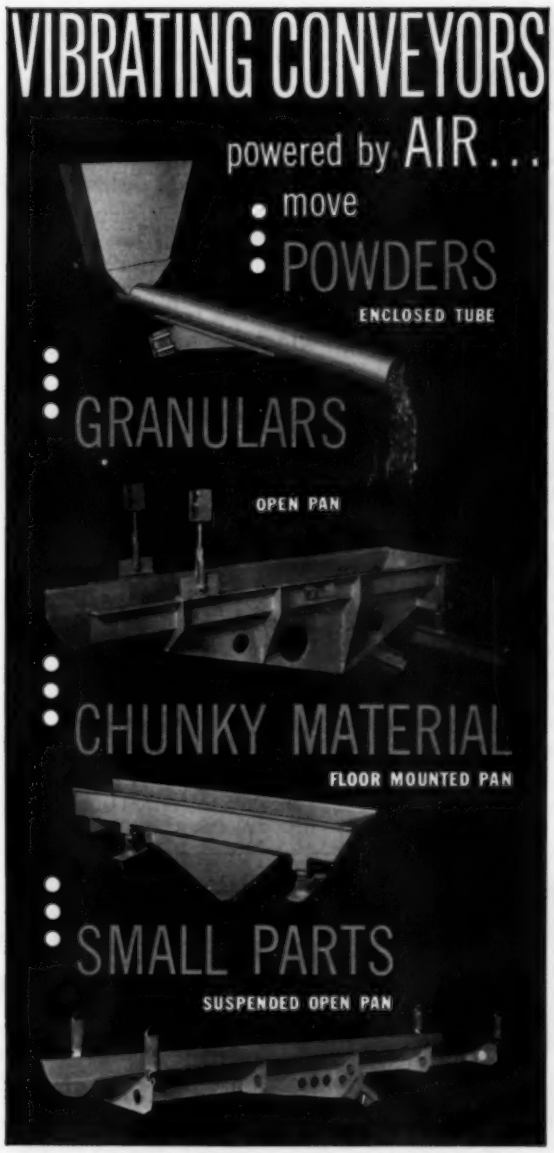
Product Parameters

Exact duplication is required for automatic assembly. Present-day production machines are capable of giving results approaching exact duplication but they will never meet it precisely because of the many variables encountered. Tool wear, machine-capability, variations in materials, and temperature are a few of these variables. Each of these variables can be minimized or even eliminated. However, this is a costly procedure and could make manufacturing costs prohibitive. To overcome this problem, the product designer must design into a product the ability to accept the result of these variables without affecting product performance. The limit to amount of variable that can be accepted is not in all cases controlled by the fit required or product performance but also by the amount of variance that can be accepted by a mechanism required to assemble the product part.

Applications do arise where the product cannot accept, to any great degree, tolerance variables in the final assembly. At the same time it is not practical or economically feasible to eliminate them in the manufacturing stage.

Under hand assembly, the worker fitted parts by trial and error until an assembly was obtained, or parts were custom fitted by filing or forcing, frequently to the detriment of product quality and performance. The next step in the assembly evolution was to gage the dimensional size of individual parts, classify them into size groups, and selectively fit mating components in assembly. Each of these systems is time-consuming, costly, and subject to human error.

A refinement of the second system can be incorporated into an automatic assembly machine. The



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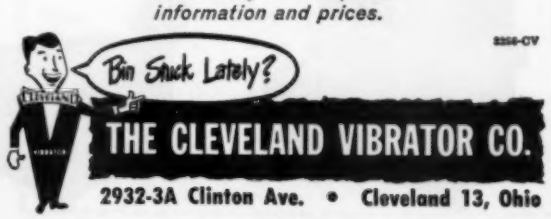

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gaging equipment is a part of the assembly machine, and it inspects each part as it enters the machine. The mating parts are also gaged and classified and stored in racks or magazines at the assembly machine. As the random-size parts are inspected in the assembly machine, a size signal is initiated that causes a proper size mating part to be fed into assembly position from the storage racks or magazines. This system reduces cost and minimizes the human element.

Of major concern in any automatic operation is part orientation. Various operations require orientation from general location to very accurate positioning within a few tenths of thousandths of an inch. In an effort to reduce manufacturing cost the product designer does not attempt to place tolerances on surfaces other than those requiring close fits at assembly. Generally it it not possible to locate from and assemble to the same surfaces. This indicates that location must be attained from some other surface. The product designer can provide these locating surfaces, such as a notch, protrusion, locating holes, machine surfaces, tabs, and ears.

One of the requisites of an automatic assembly machine is to determine part presence at each working station. This prevents the machine from attempting to assemble additional parts into an empty station. Several methods are used to determine part presence. One is the photoelectric cell. The photoelectric cell lends itself particularly to small lightweight parts.

Product design of parts that are anticipated for automatic assembly must take into consideration a number of factors that normally would not interfere with manual assembly methods. Parts with sharp edges and burrs are a great hazard to mechanical feeding and conveying methods. They can cause major downtime problems in clearing jams and removing stuck parts. Chamfering of holes that take pins, rivets, or shafts is extremely helpful in preventing excessive machine downtime and also in reducing the accuracy required for part positioning.

To further reduce part-handling problems it is possible to manufacture simple parts in the assembly machine. For example, shims, washers, springs, and gaskets are a few of the parts falling into this category. Springs are especially suitable for this approach as they are extremely difficult to handle and feed automatically.

Fastening Parts

Methods of fastening parts after they are assembled is of extreme importance in determining the feasibility of automatic assembly for a product. Riveting and staking are particularly fine methods as these operations generally do not require additional parts such as screws, nuts, and snap rings. Also, the devices used for staking and riveting are simple and easy to maintain. Parts assembled with screws are suitable for automatic assembly operations but require rather intricate equipment for feeding and driving. Snap rings and retaining rings are also suitable, providing some thought is given to design of the rings. Retaining rings have an

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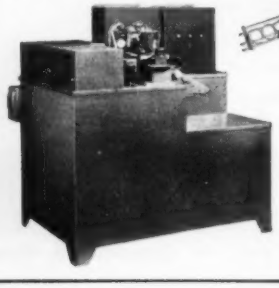

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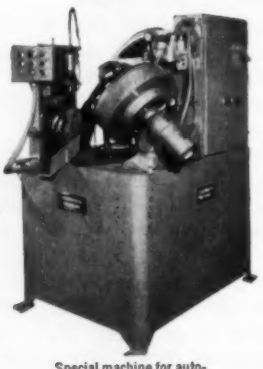

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affinity for tangling, making feeding very difficult.

Automatically feeding parts into a machine often imposes the problem of marring external surfaces. Painted parts are particularly subject to this problem which is caused by the tumbling, abrading, or vibrating action of part feeders. Where possible, the painting operation should be performed after assembly or, if not possible, consideration should be given to some other type of surface finish which would be more durable.

From a paper entitled "Designing Parts for Automatic Assembly," presented at the ASME Design Engineering Conference and Show, New York, May 1960.

POTENTIAL FOR THE SIXTIES

By DAVID SARNOFF
Chairman of the Board
Radio Corp. of America
New York, N. Y.

THERE is an inevitable time gap between research and product introduction. The full impact of 1960's achievements, and those of even earlier years, will come later. The explosive expansion of research was not ignited until the mid-fifties. Half of the $85 billion spent on research and development in the United States since Pearl Harbor has been spent in just the last four years.

The normal laboratory-to-market place cycle is about seven years, so we can reasonably look for new developments to become a dominant factor in the mid-sixties. The flow of new products and processes will accelerate sharply, just as research itself has accelerated. There will be heavy capital investment for "tooling up" in many industries—not more of the old, but of new and revolutionary kinds of equipment, much of it electronic.

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From an article entitled "Coming: A New Era of Discovery" appearing in "RCA Electronic Age," Winter 1960/61 *issue, published by Radio Corp. of America, New York.*

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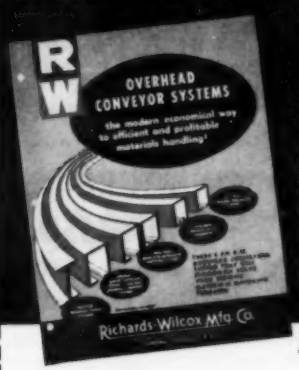
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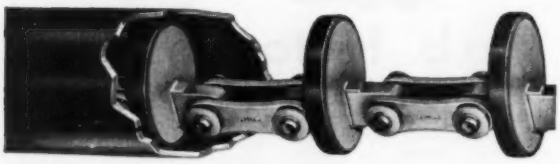

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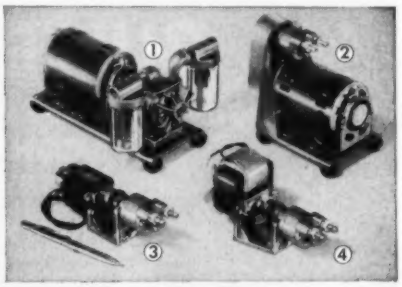

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By Andrew J. Briggs, service building superintendent, May Co.; 303 pages, 6 by 9 inches, illustrated, published by John Wiley & Sons Inc., New York; available from AUTOMATION; *$8.50 postpaid.*

Book is designed to cover in a step-by-step manner various phases of planning and managing a warehouse operation. Discussion brings out factors to study, points in selecting and designing equipment, operating procedures, and management reports. Equipment considered ranges from hand trucks to automated order picking systems.

PRINCIPLES OF CONTROL SYSTEMS ENGINEERING

By Vincent Del Toro, associate professor of electrical engineering, and Sydney R. Parker, assistant professor of electrical engineering, City College of New York; 686 pages, 6 by 9 inches; published by McGraw-Hill Book Co., Inc., New York; available from AUTOMATION; *$14.50 postpaid.*

Text was written for college seniors and graduates including nonelectrical engineering students. Various methods of analysis and design are presented through discussion of five phases. Fundamental areas covered are: Basic concepts of feedback control and mathematical background; analysis and design in the time domain; frequency-domain techniques; complex-frequency-domain techniques (root-locus method); and use of the electronic computer approach.

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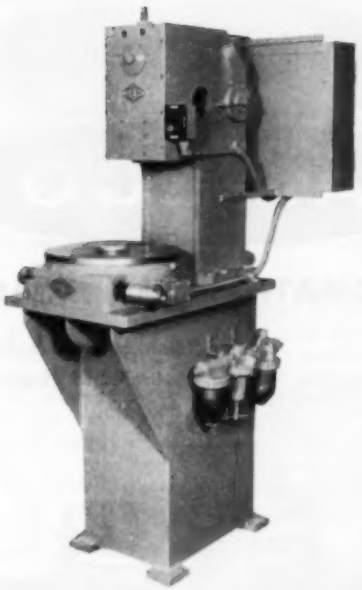

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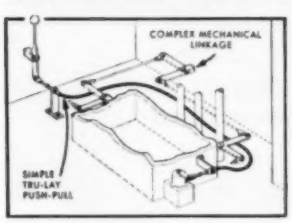

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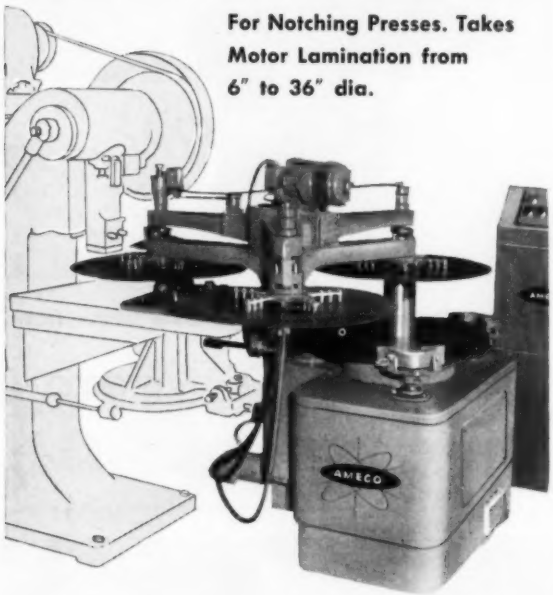

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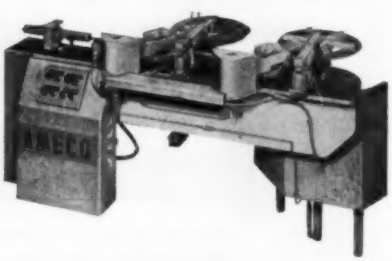

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analytical method is presented, empirical relationships are cited. Besides an extensive system of cross referencing, this book includes four indices that list French, German, Russian, and Spanish equivalents of the terms defined.

PLANNING PRODUCTION, INVENTORIES, AND WORK FORCE

By Charles C. Holt, John F. Muth, Herman A. Simon, all of Carnegie Institute of Technology, and Franco Modigliani, Northwestern University; 431 pages, 6 by 9 inches, published by Prentice-Hall Inc., Englewood Cliffs, N. J.; available from AUTOMATION; *$10.00 postpaid.*

Decision-making methods and how they may be applied to managerial decisions in the operation of a factory-warehouse system are discussed. The book is based primarily on research done for the Office of Naval Research. It considers decision rules for planning production and work force, scheduling of individual products, design of decision system, and generalization of decision methods.

AN ILLUSTRATED DICTIONARY OF PLUMBING TERMS

By Evan Berry; 244 pages, 4 by 7 inches, illustrated, published by Philosophical Library Inc., New York; available from AUTOMATION; *$6.00 postpaid.*

Alphabetical presentation explains terms in general use in the plumbing industry. Many sketches are used to illustrate terms.

Association Publications

AMERICAN DRAFTING STANDARDS MANUAL; SECTION 15; ELECTRICAL DIAGRAMS

Paperbound, 20 pages, 8½ by 11 inches, illustrated; available from American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.; $1.50.

American Standard publication ASA Y14.15-1960 contains definitions and general information applicable to most of the commonly used electrical diagrams. It includes detailed recommendations on preferred practices in the preparation of such diagrams.

DIMENSION IDENTIFICATION CODE FOR FLUID POWER CYLINDERS

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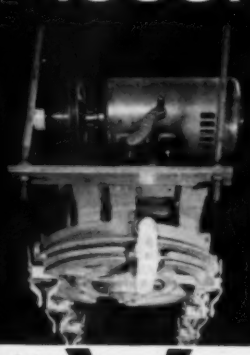

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VIBRA-WASHER

. . . THE COMPLETELY NEW AUTOMATIC PARTS WASHER AND METAL CONDITIONING MACHINE

- **Labor saving**
- **Automatic unloading**
- **For single or multi-stage operations**
- **No nesting of parts during cleaning or conditioning cycle**
- **Adjustable capacities to 10,000 lbs. per hour**

The versatile new Simplicity VIBRA-WASHER, revolutionary machine for washing and conditioning of small metal parts, stampings and castings, employs a vibrating work carrier that automatically conveys parts through cleaning or conditioning bath. Solution is forced around parts, even into blind drillings and slots. In single stage, VIBRA-WASHER removes chips, oil and grease quickly . . . economically. In multi-stage, several units in line will provide cleaning, rinsing and phosphating, eliminating "between-stage" handling. Write today for Bulletin 107, to: Industrial Washer Division.

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TUBE-VEYOR an enclosed bulk handling conveyor

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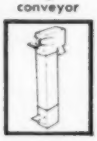

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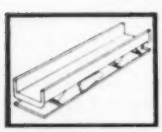

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are you stuck?

confidential file

Readers with problems concerning systems, equipment, or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Readers having solution suggestions are invited to submit them and should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

RESTATEMENT OF CASE 2183-P (January 1961)

READING AND RECORDING CAR NUMBERS

. . . Objective of automatic car identification system is to provide a means of identifying moving freight cars (5 mph to 60 mph) without necessity of a person reading the car initials and numbers. The system contemplates attaching a small device (costing less than $5 each) to each freight car which would identify car by three letters and six numbers. A scanning unit (costing less than $5000 each and located in immediate vicinity of track) would read car identification device and convert information into 5-channel Teletype signals for transmission (3 to 10 miles) and printout on paper. Same signal may be transmitted to a data processing center, processed through a converter, and fed into a computer for use in car tracing, car accounting, and related train operations. Complete specifications are available. System proposals will be received until June 1, 1961, at which time a review board will select a specific system for further development. . .

J. J. Schmidt, Assistant Director of Research
The Denver and Rio Grande Western Railroad Co.
P. O. Box 5482, Denver 17, Colo.

CASE 2293-P

INCREMENTAL SERVOS

. . . I am interested in finding a manufacturer of incremental servo actuators having a locked rotor torque of up to 8 lb-in. and a synchronous speed of 1800 rpm at 60 cycles. . .

Supervisor, Special Products Engineering

CASE 2294-P

DEPTH CONTROL FOR WOOD CUTTING TOOL

. . . Do you know of any pneumatic, electrical, or mechanical device which will maintain a wood cutting tool at a predetermined depth, say 3/32 inch, in relation to the surface of a curved wood block? The surface may vary from nominal (expected) form as much as minus 1/16 inch due to sanding. . .

Project Engineer

CASE 2299-P

SENSING DRILL BREAKAGE

. . . On an automatic bead-drilling machine we need a method of signaling drill point breakage. Two 1/16 inch diameter drills operate at several thousand rpm on opposite sides of a urea or melamine bead. The drill feeds are slightly out of phase to produce a straight-through hole. Space is limited, and mechanical "feelers" are impractical. We have tried an ultrasonic sensing device with no success. . .

Sales Manager

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Why YOU will want to plan <u>now</u> to attend the

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Purdue University, Lafayette, Indiana • April 17 to 19

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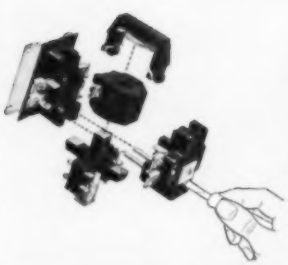
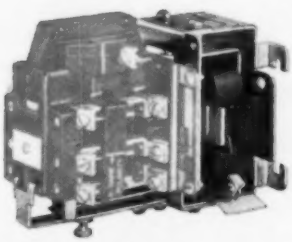


Disassembly from front in 20 seconds makes Square D Type D relays easiest to maintain



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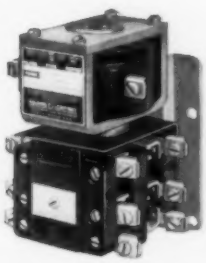
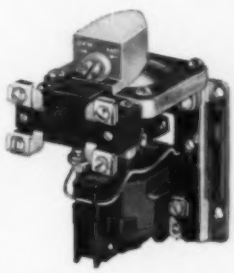


DC relays have contact arrangements and mounting hole dimensions identical to AC



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